US008215540B2

(12) **United States Patent**
Szesko et al.

(10) **Patent No.: US 8,215,540 B2**
(45) **Date of Patent: Jul. 10, 2012**

(54) **AUTOMATED LABEL VERIFY SYSTEMS AND METHODS FOR DISPENSING PHARMACEUTICALS**

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(73) Assignee: **Omnicare, Inc.**, Covington, KY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 687 days.

(21) Appl. No.: **12/235,173**

(22) Filed: **Sep. 22, 2008**

(65) **Prior Publication Data**

US 2009/0173779 A1 Jul. 9, 2009

Related U.S. Application Data

(60) Provisional application No. 60/974,181, filed on Sep. 21, 2007, provisional application No. 61/076,905, filed on Jun. 30, 2008.

(51) **Int. Cl.**
G06F 17/00 (2006.01)

(52) **U.S. Cl.** **235/375**; 235/376; 235/475

(58) **Field of Classification Search** 235/375, 235/376, 475, 483, 481

See application file for complete search history.

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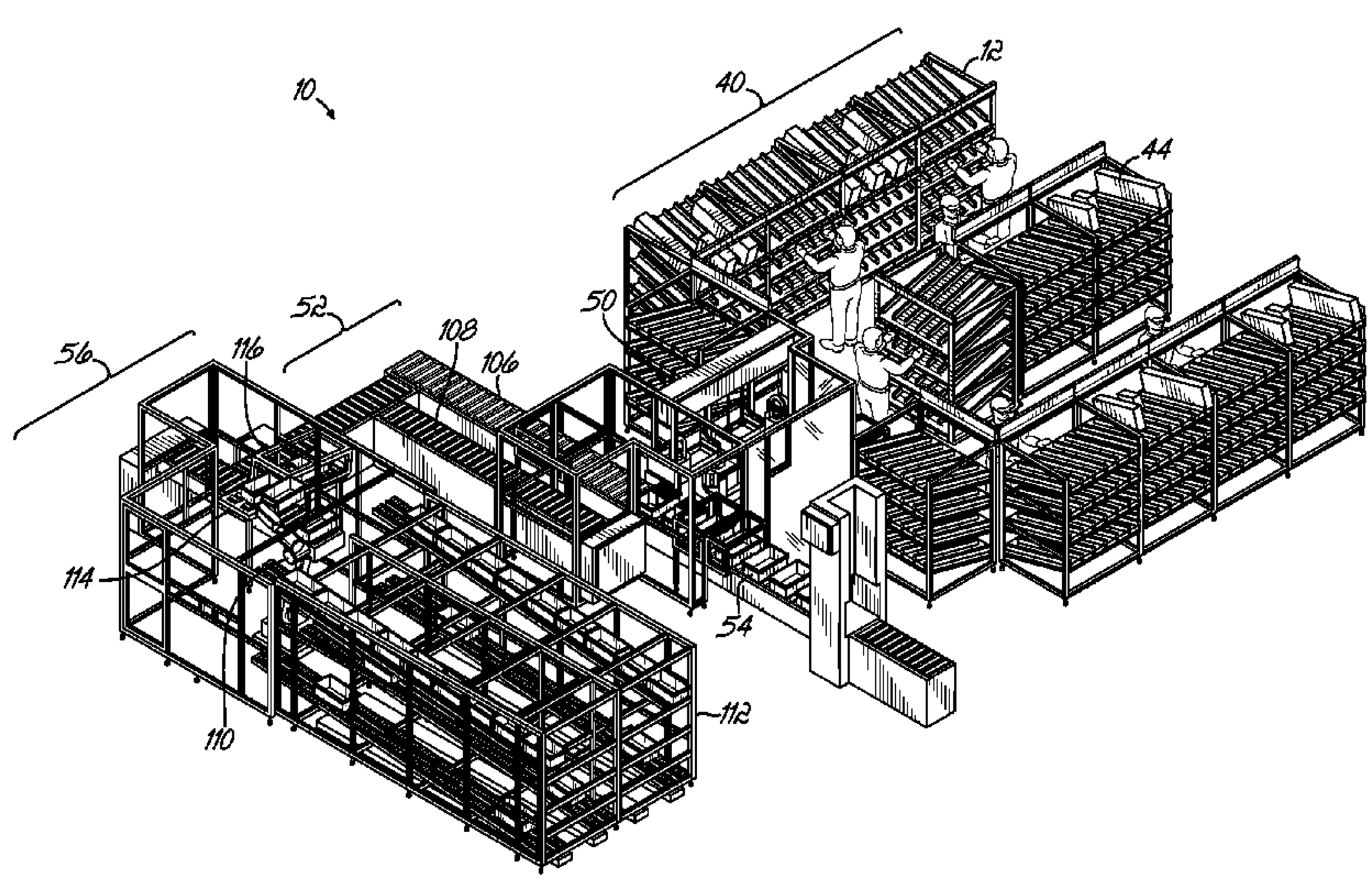
Primary Examiner — Edwyn Labaze

(74) *Attorney, Agent, or Firm* — Wood, Herron & Evans, LLP

(57) **ABSTRACT**

Apparatus and methods for filling a customer order with plurality of products each containing a pharmaceutical. The apparatus and method automatically verify a product barcode on each of the product, print a patient label with a patient barcode for each product, apply the patient labels to at least some of the products, and independently verify that the product barcode matches the proper patient barcode.

54 Claims, 31 Drawing Sheets



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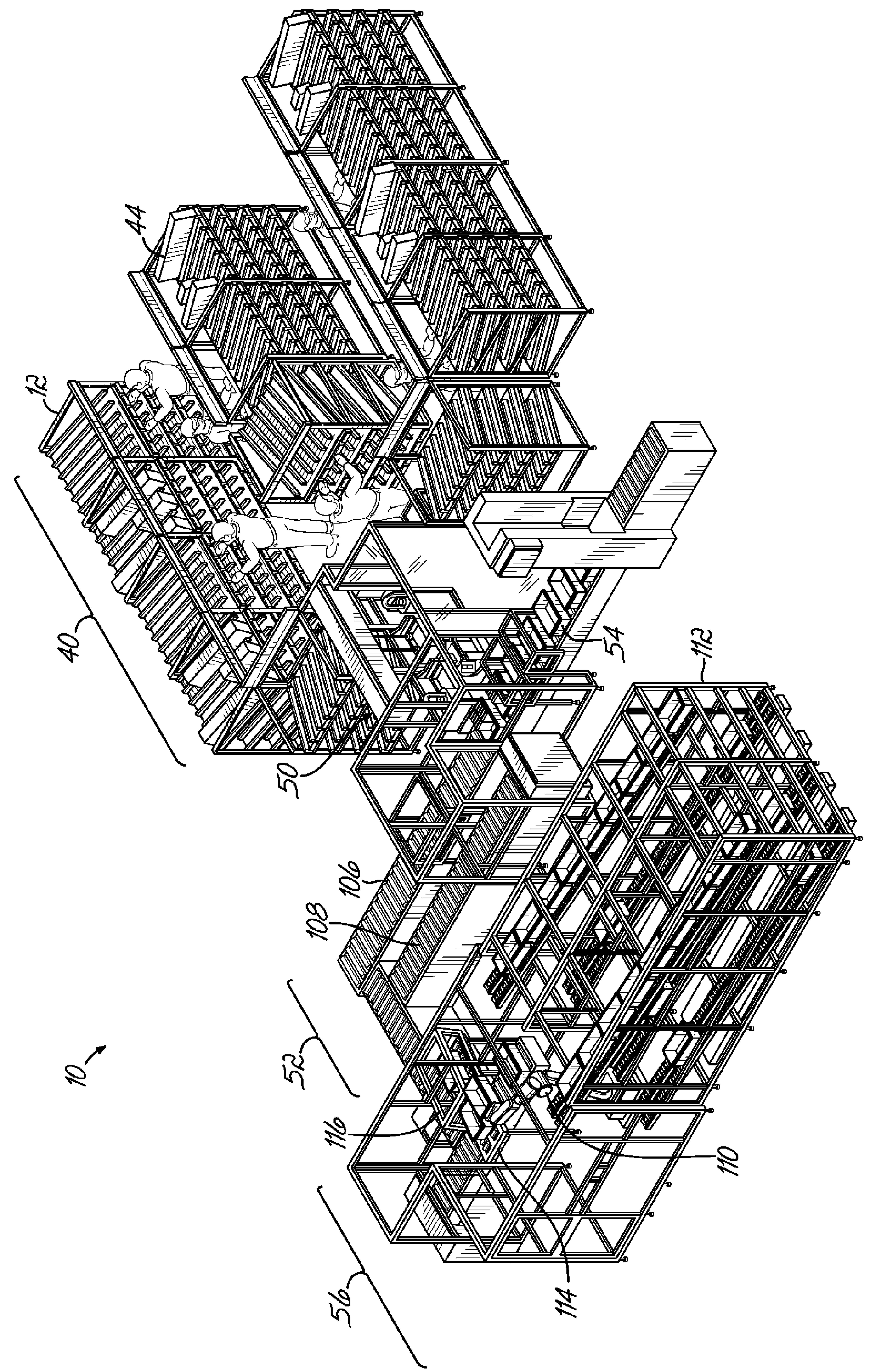
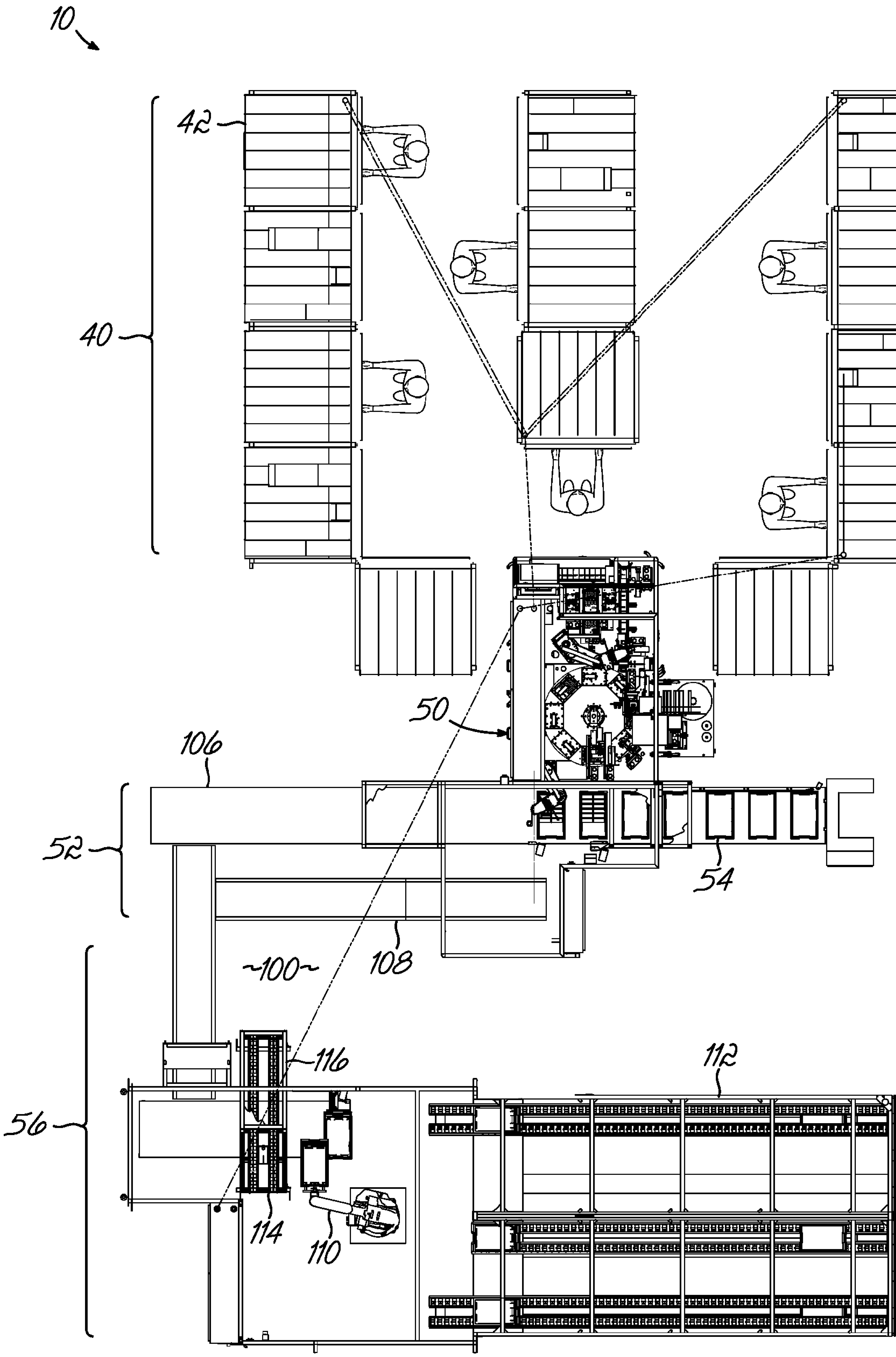


FIG. 1



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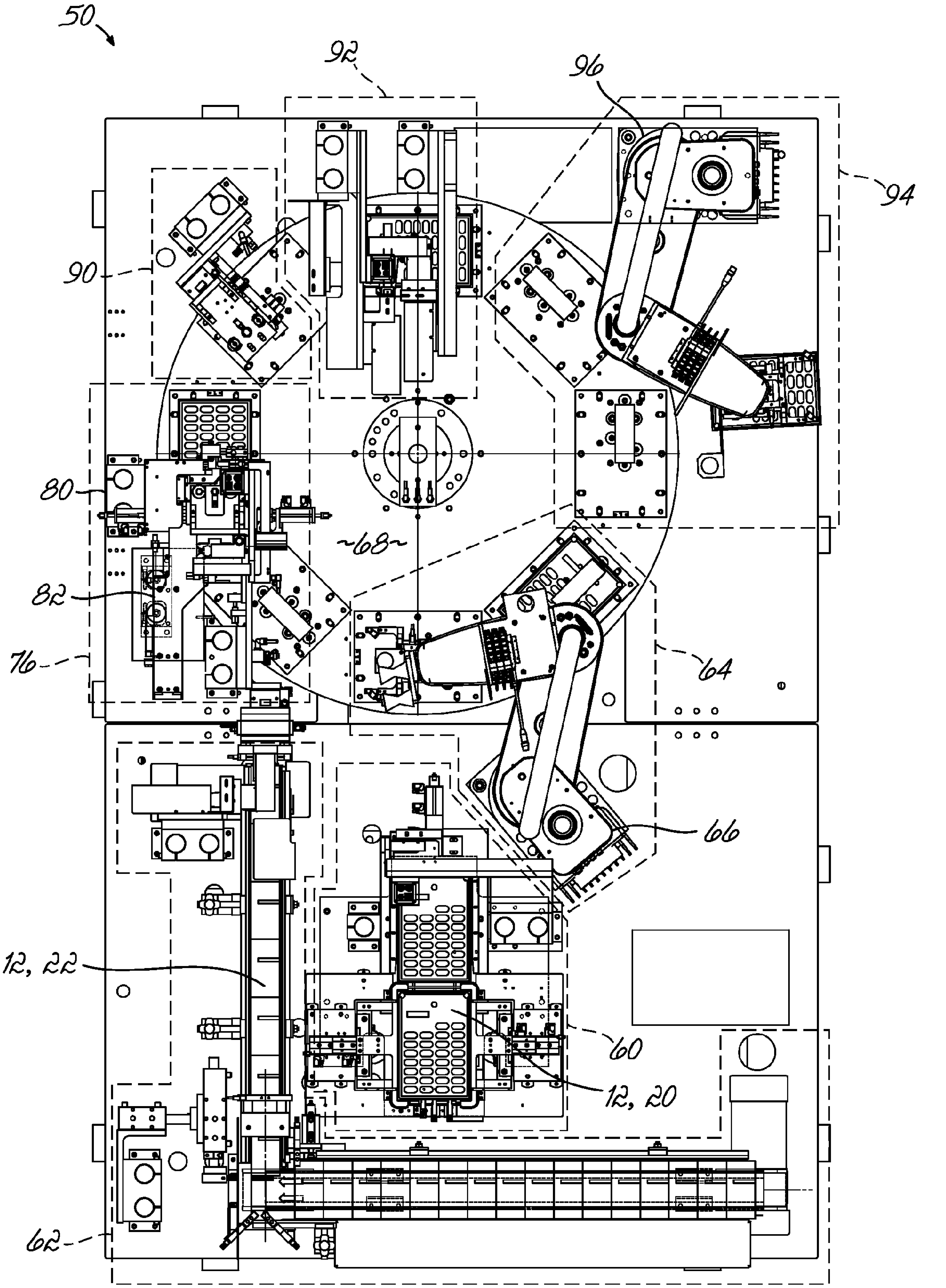

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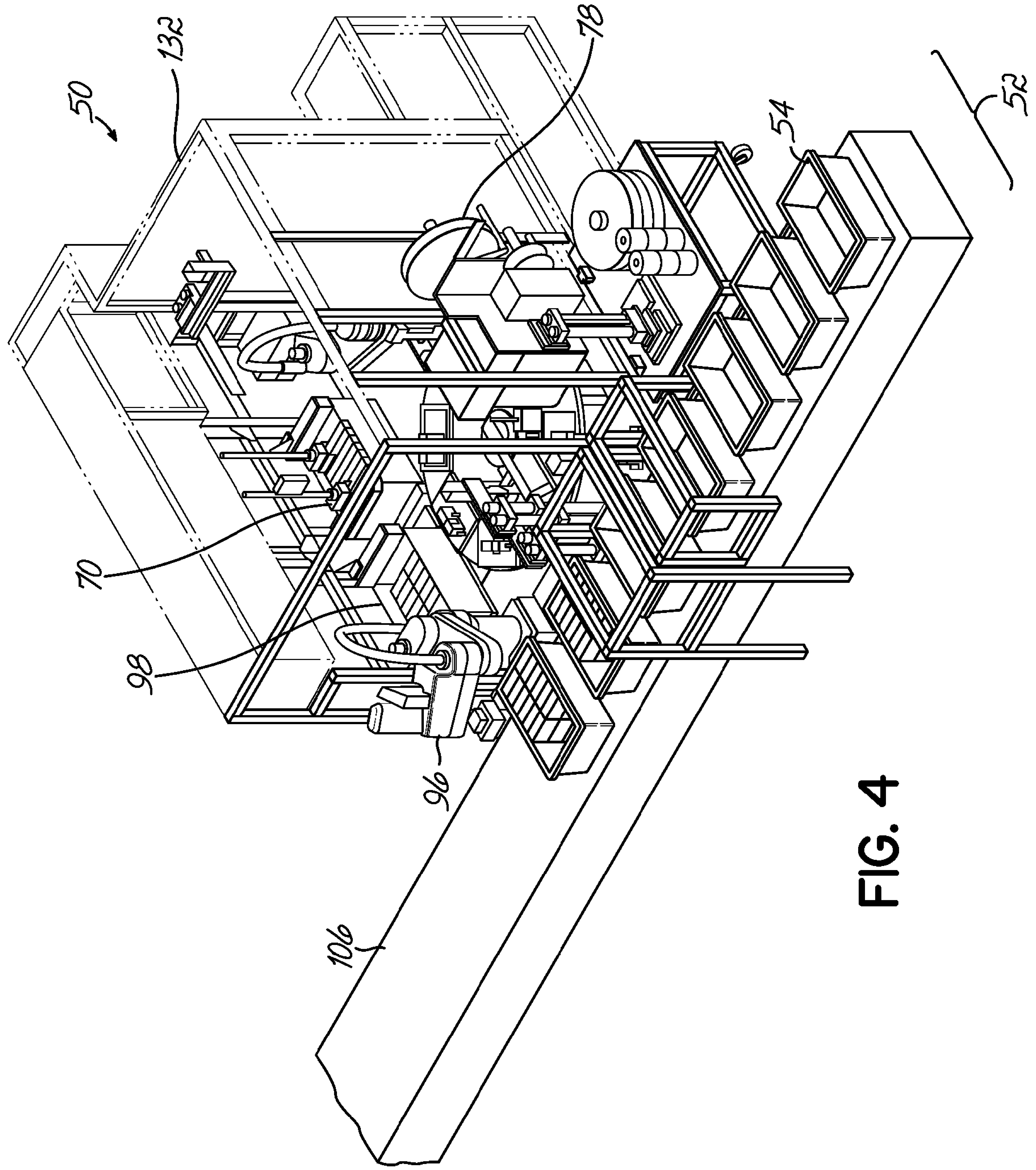

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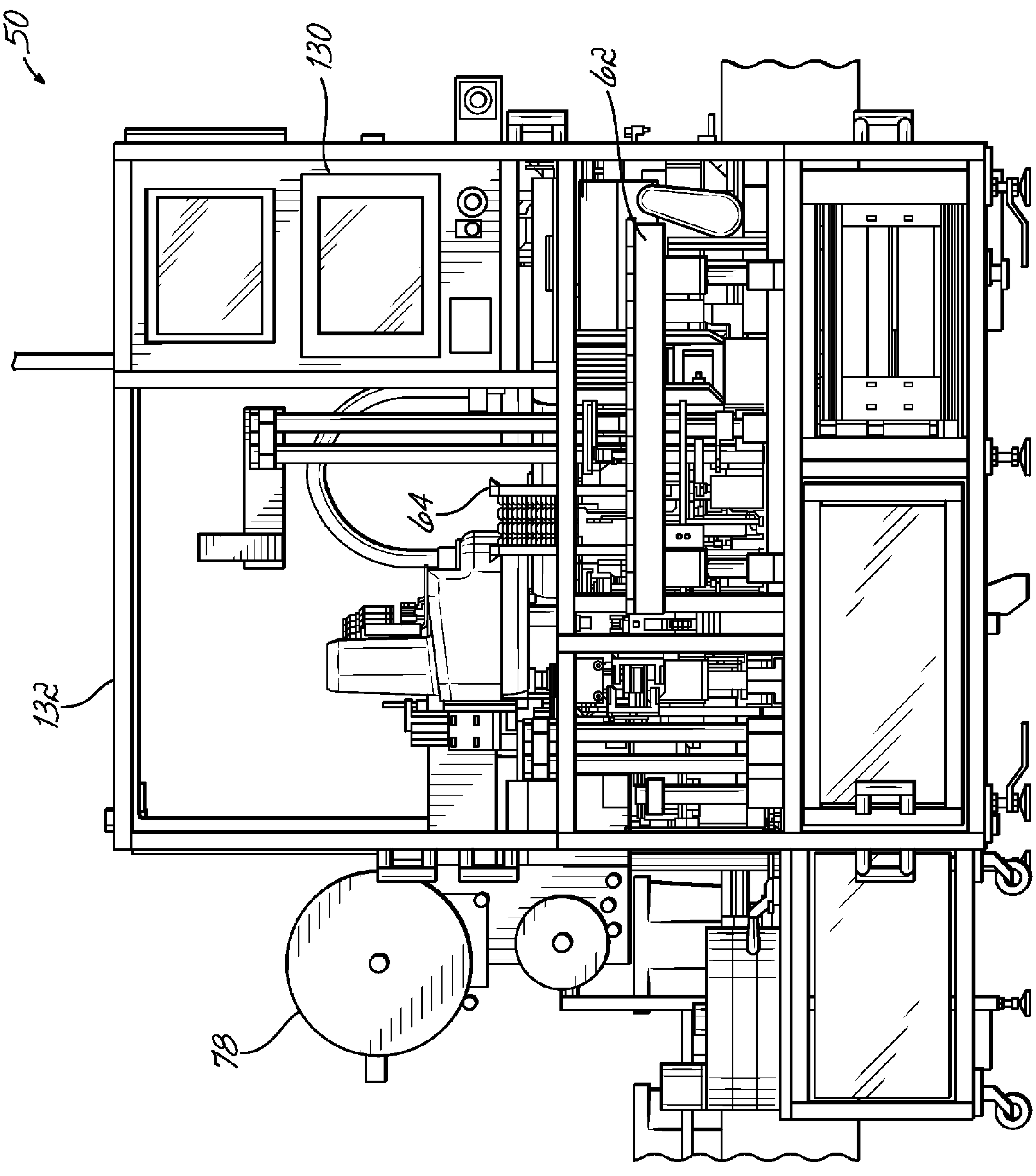

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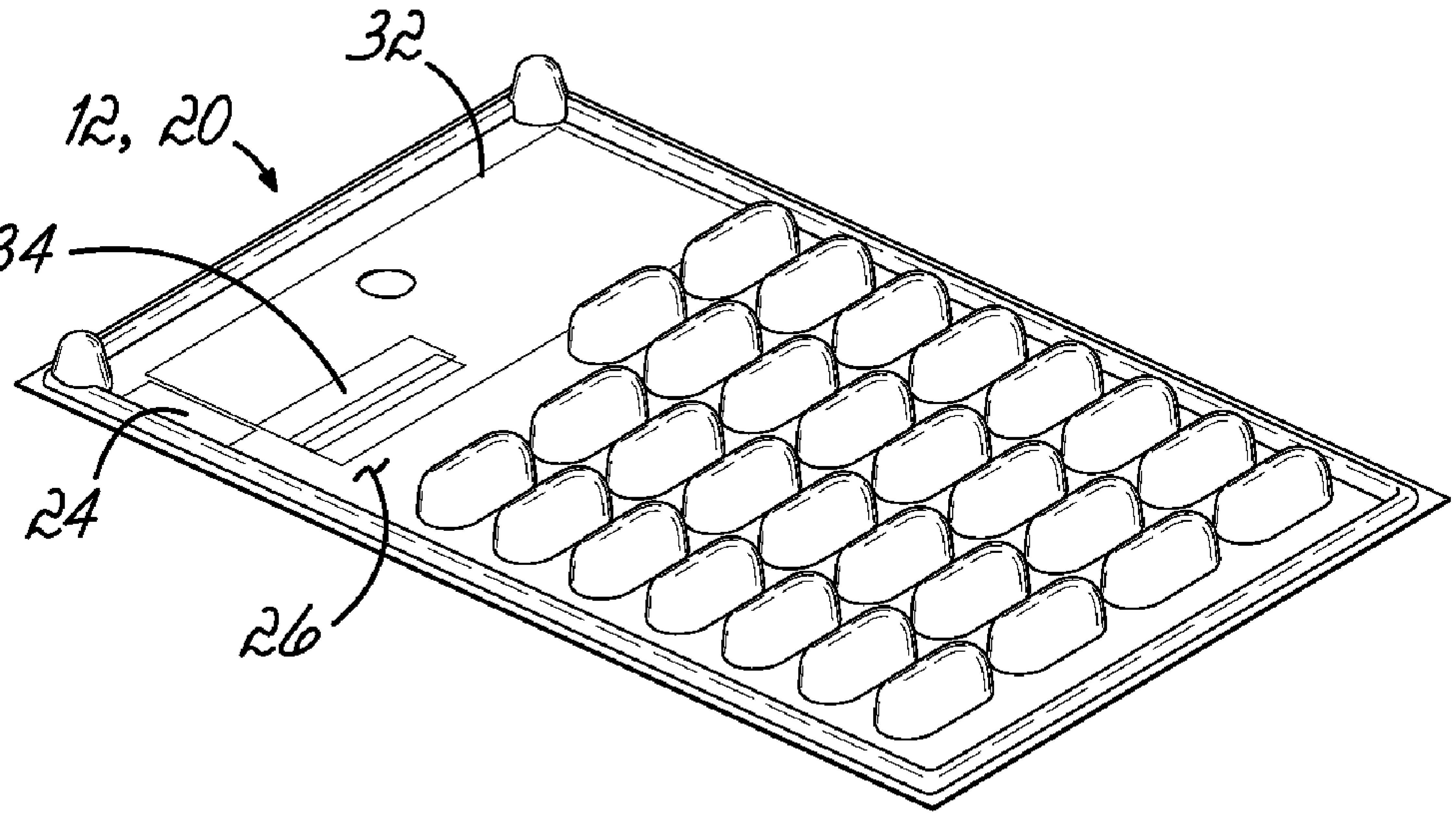

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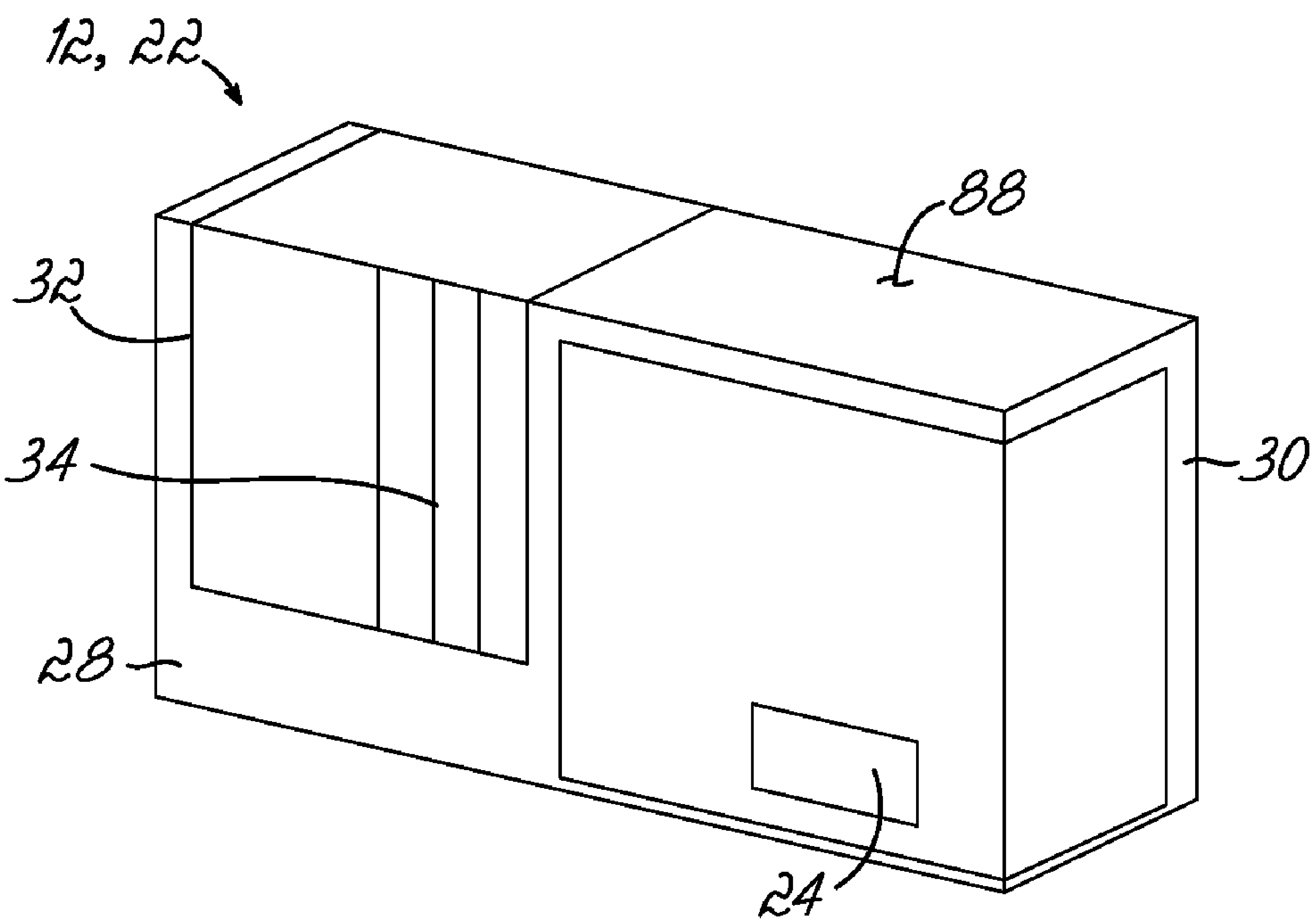

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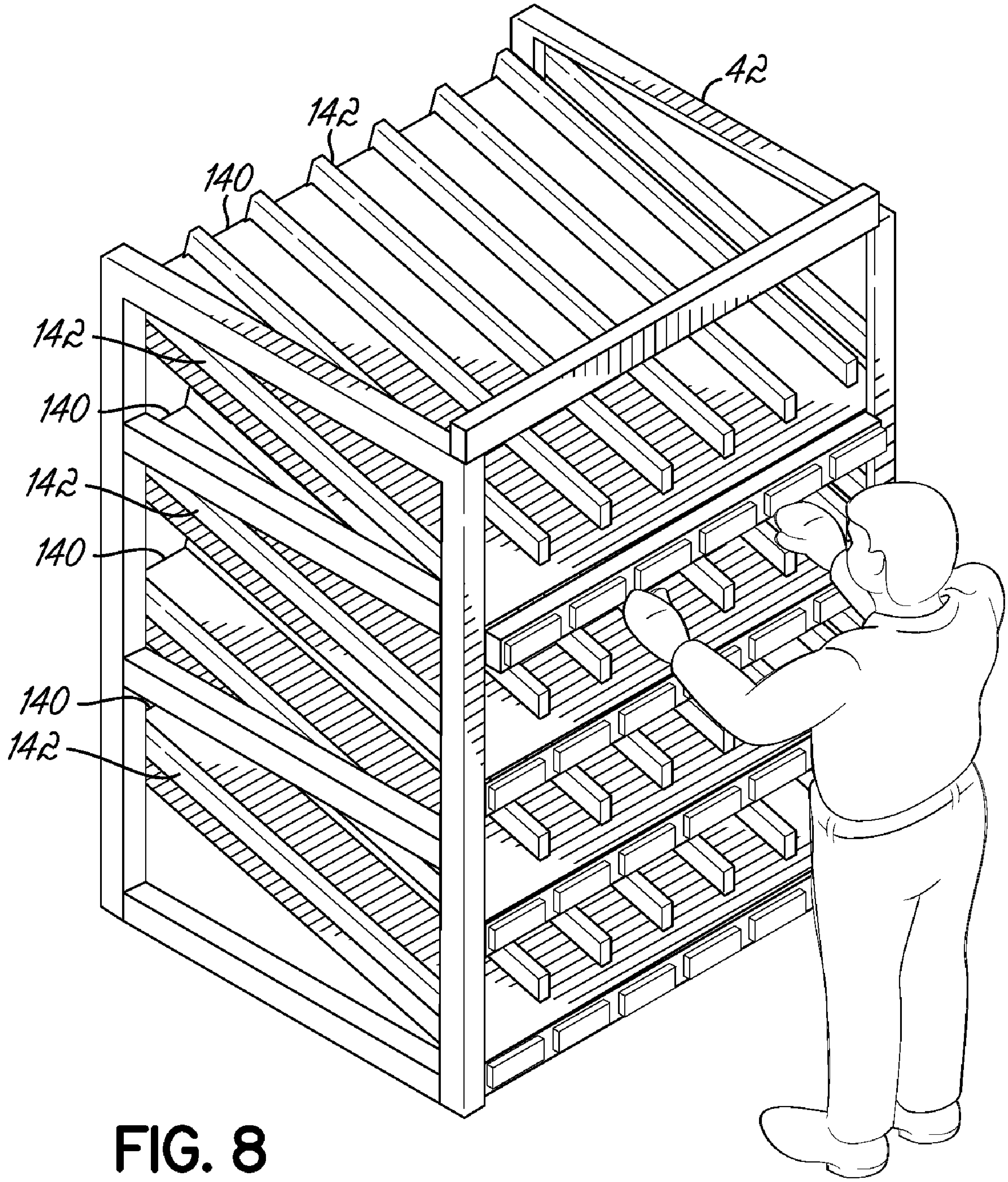

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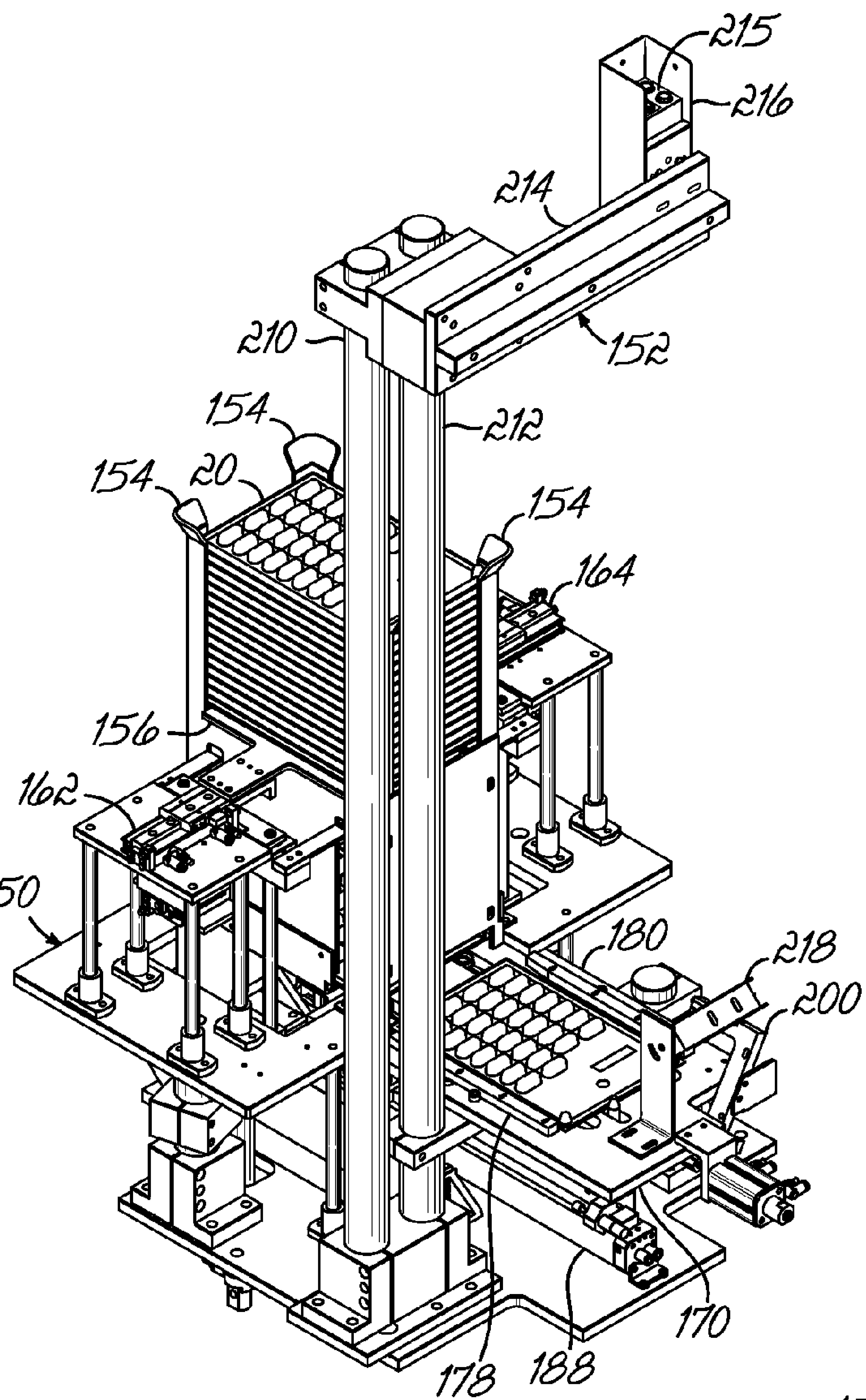

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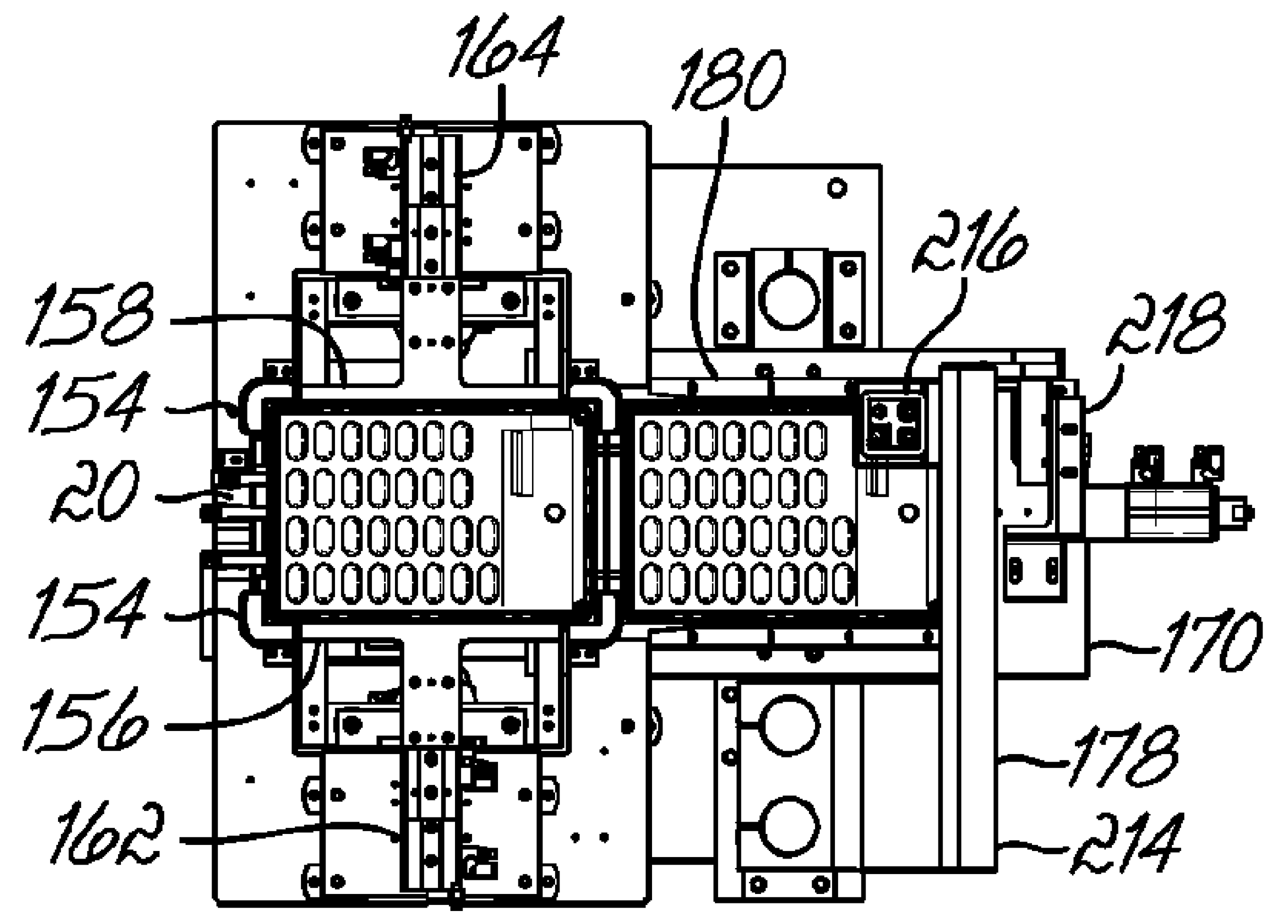

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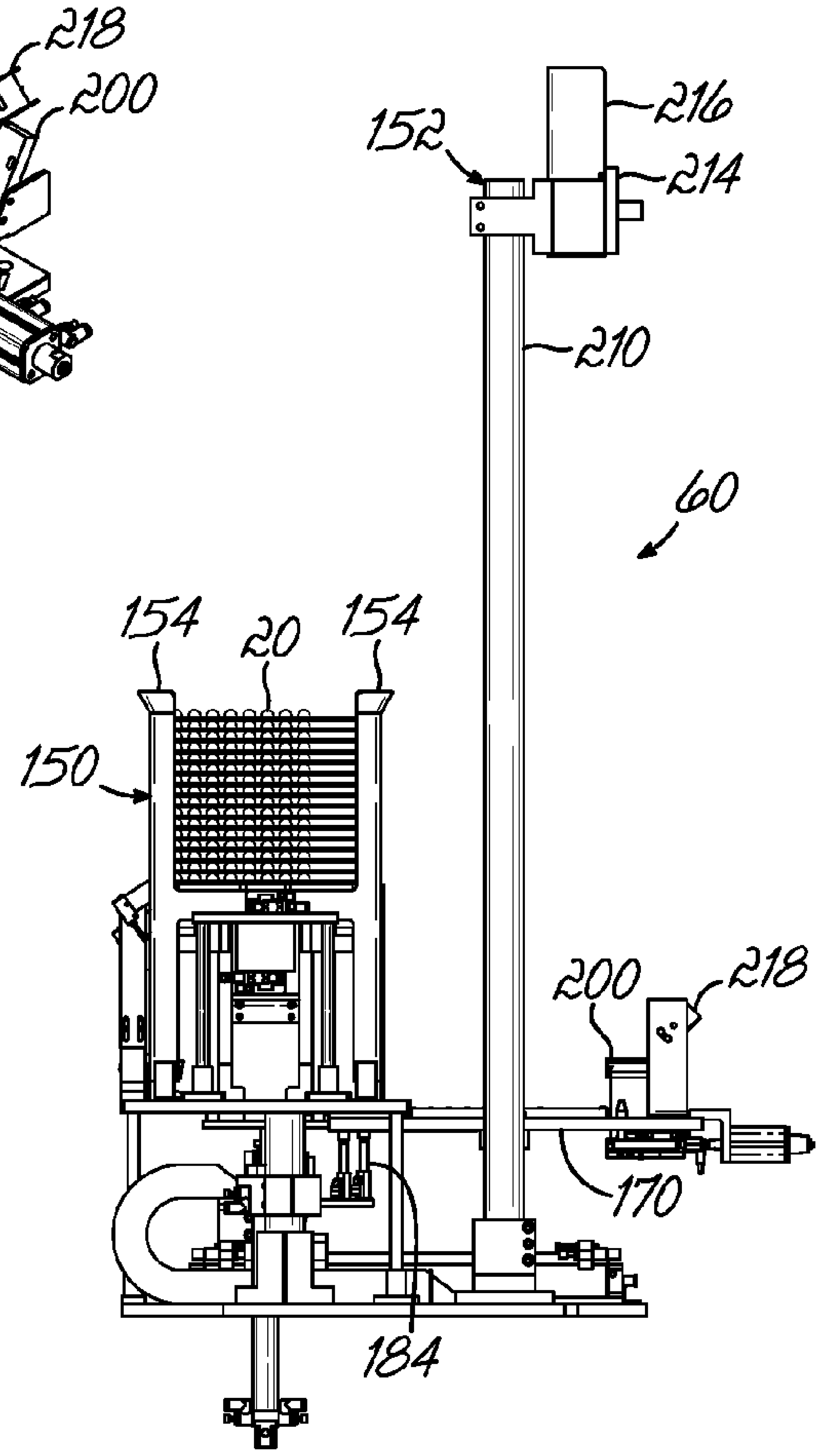

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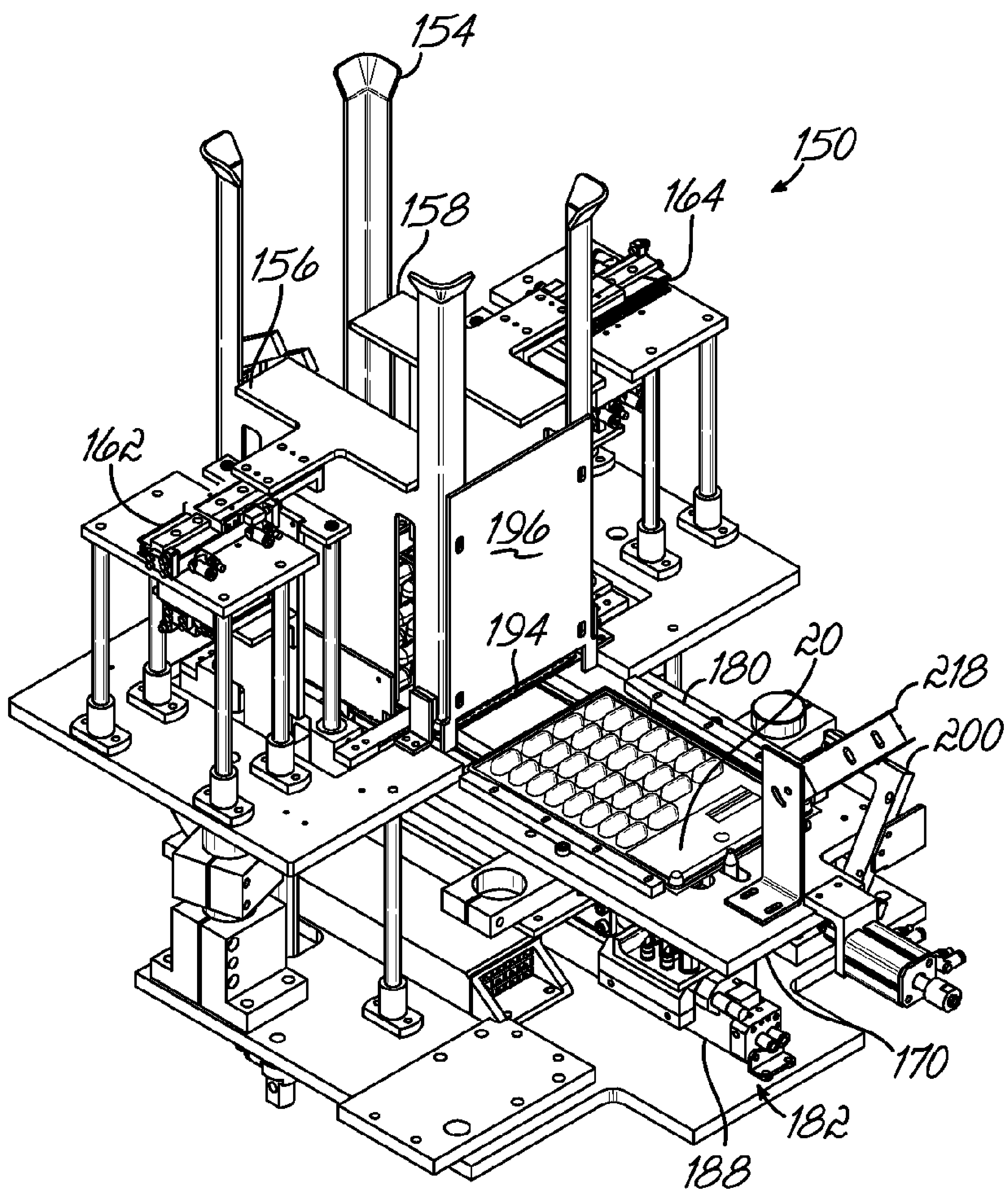
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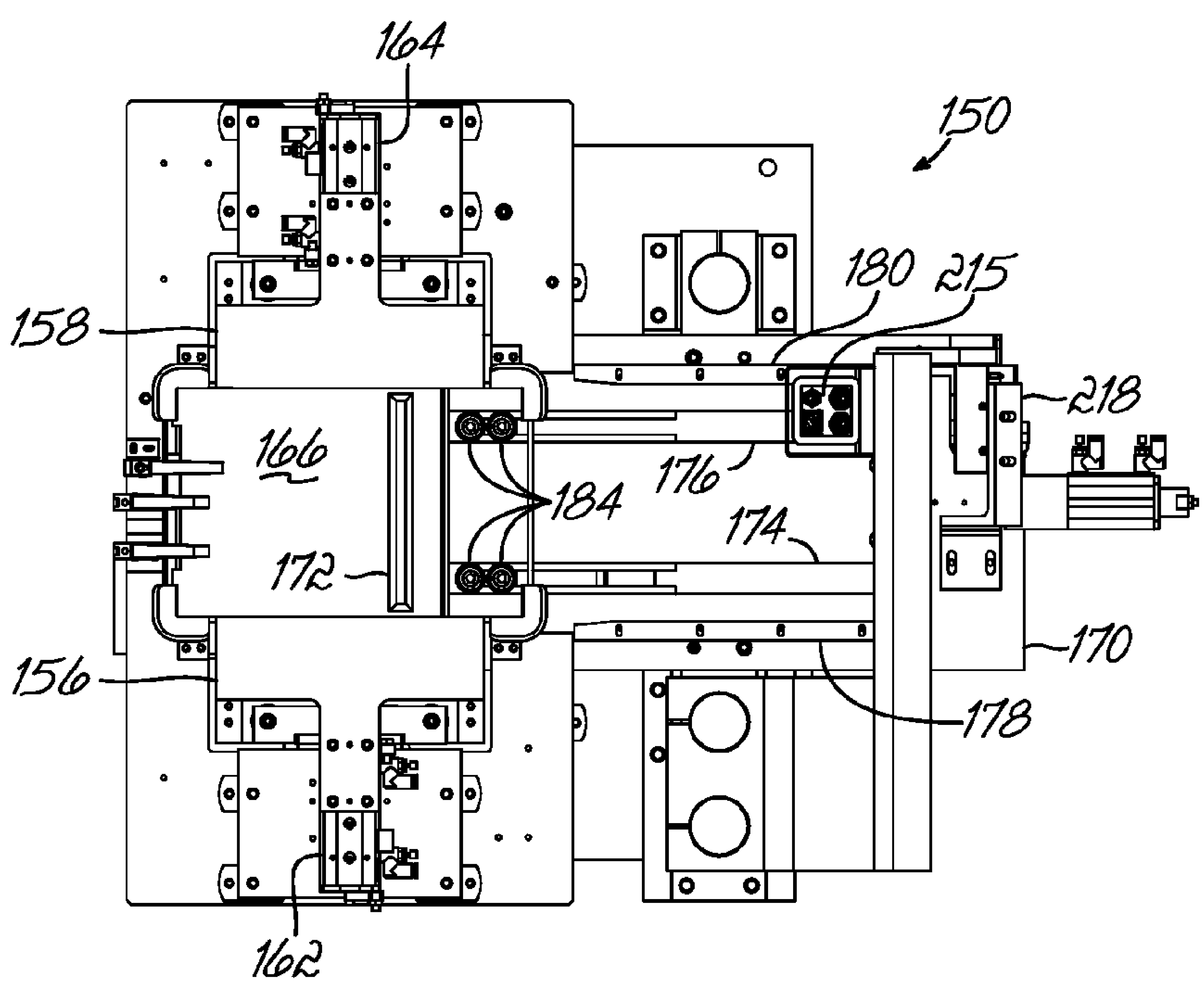
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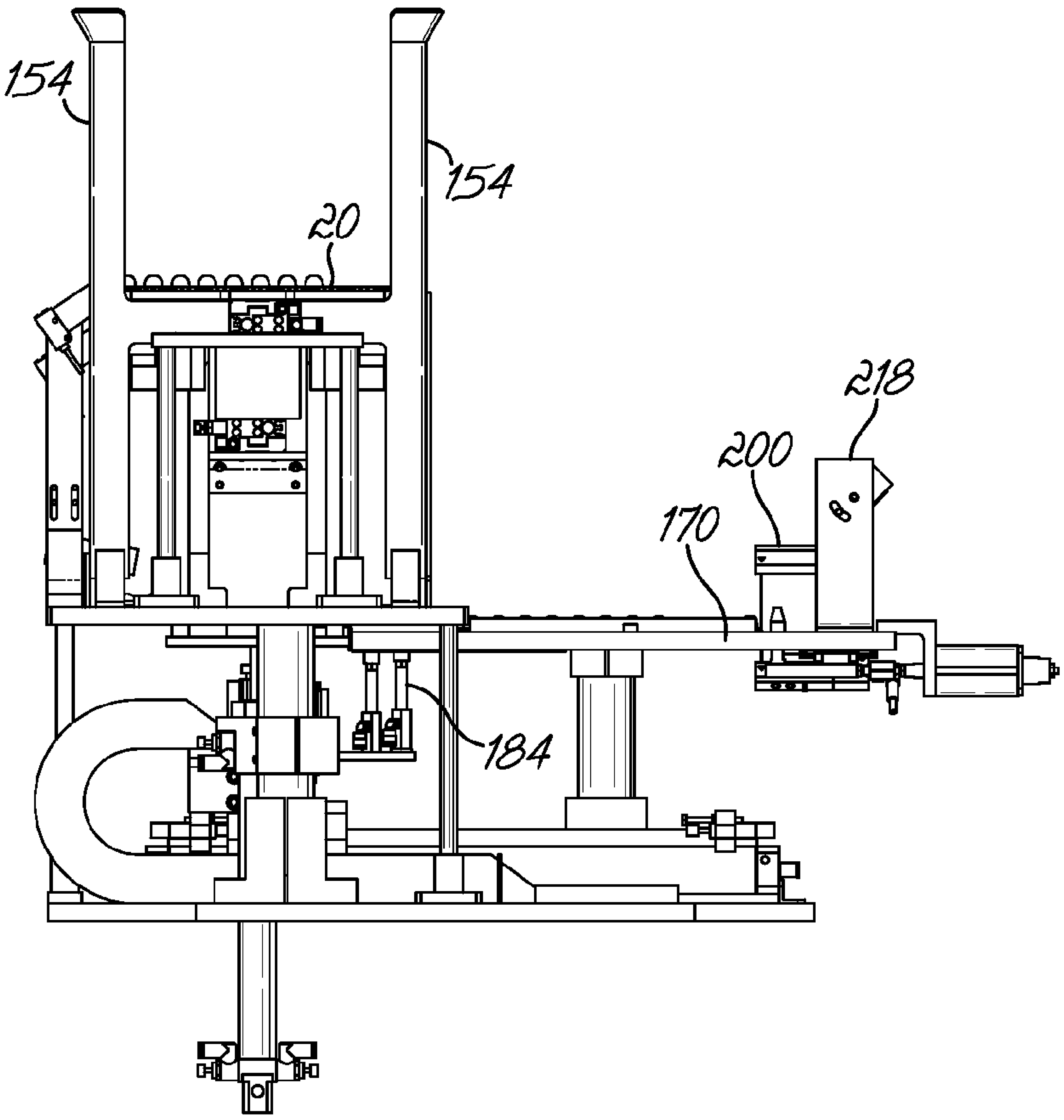
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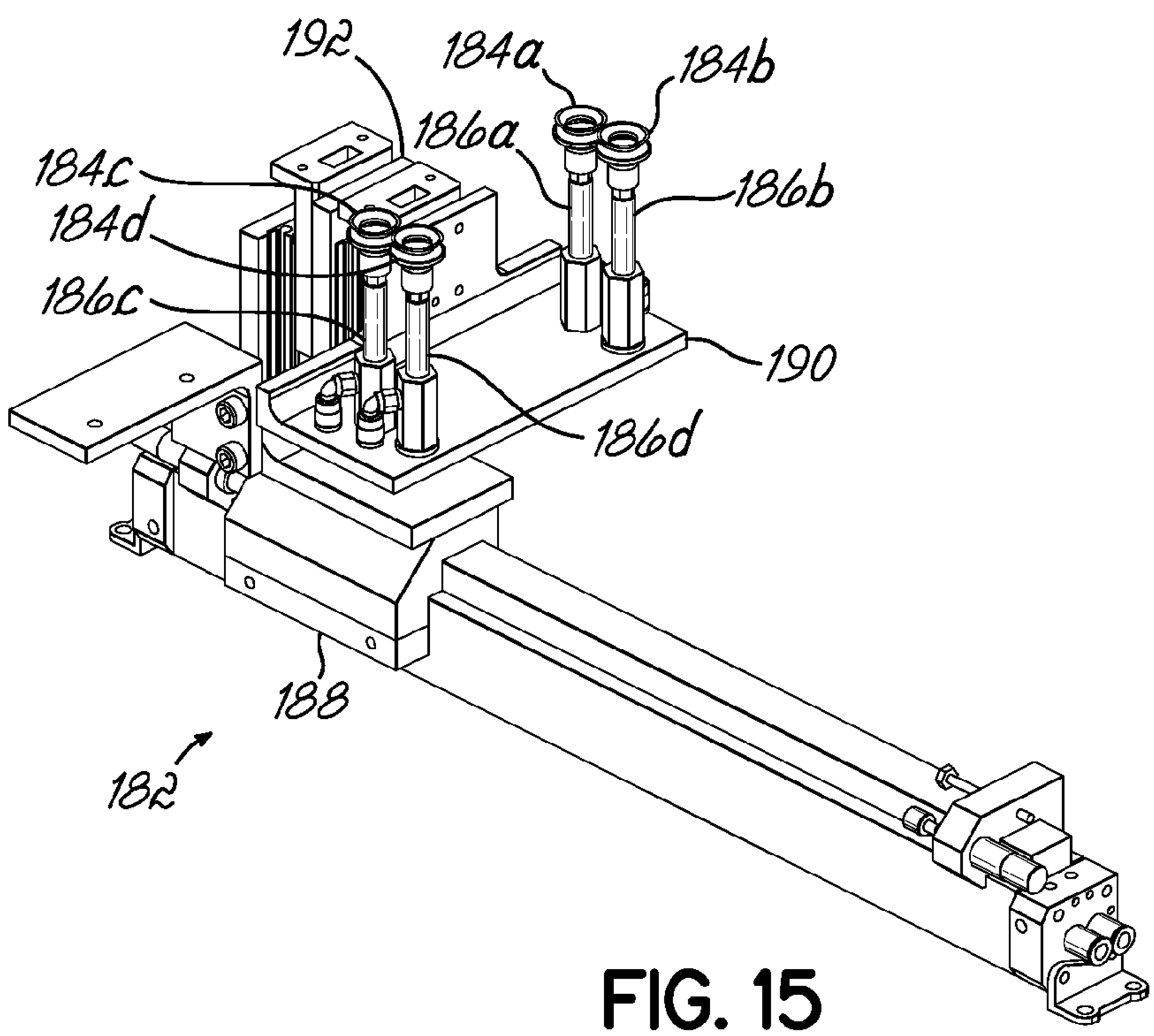
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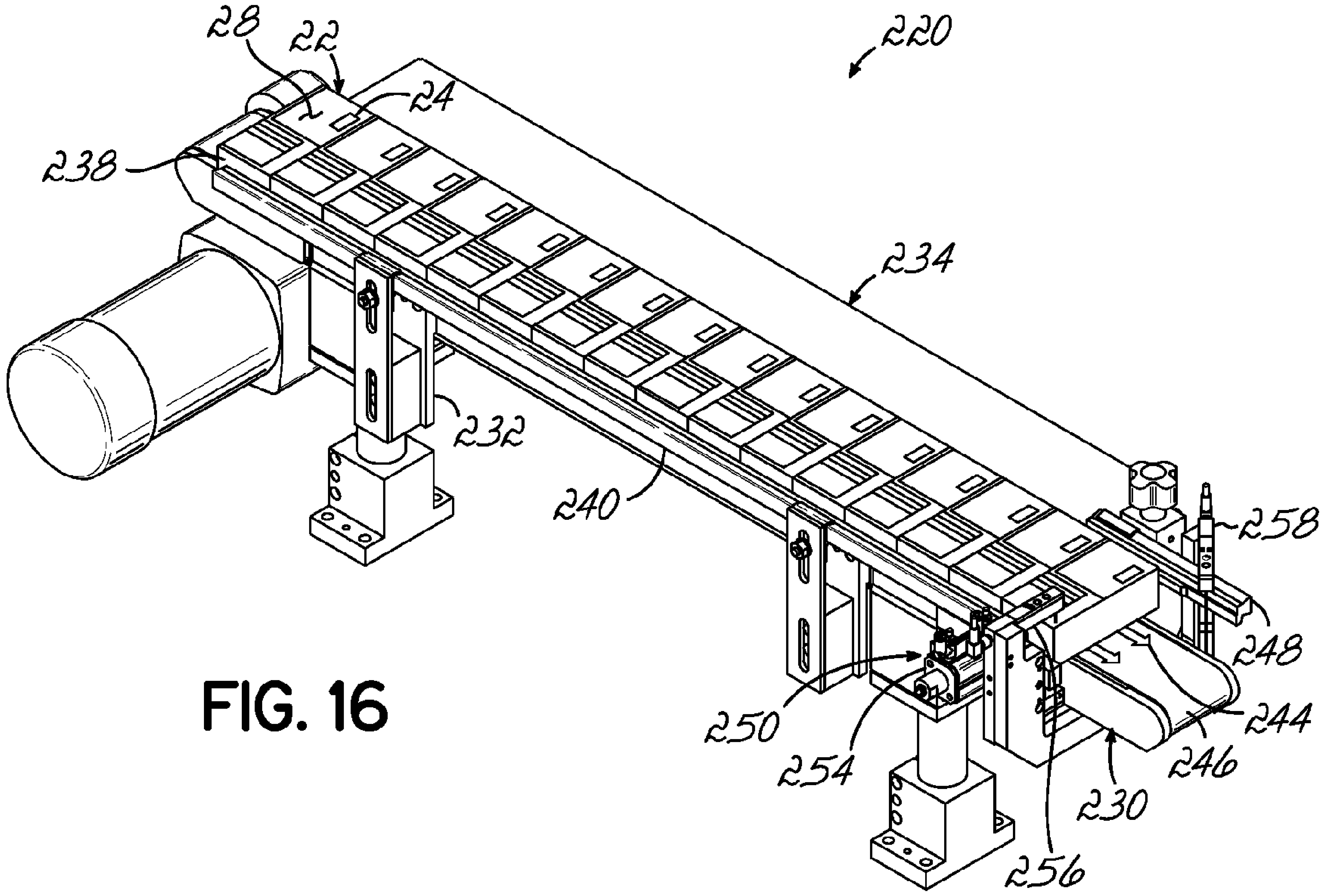
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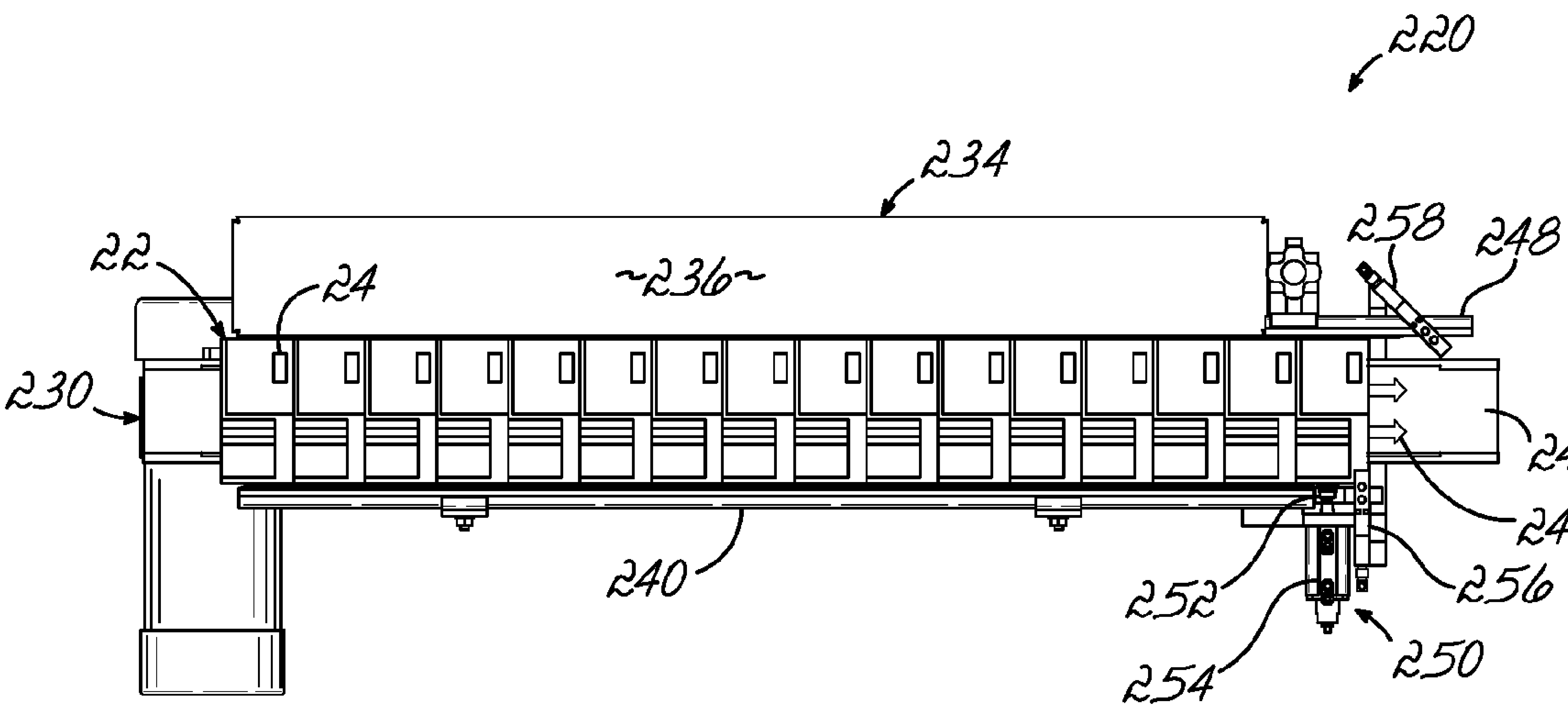
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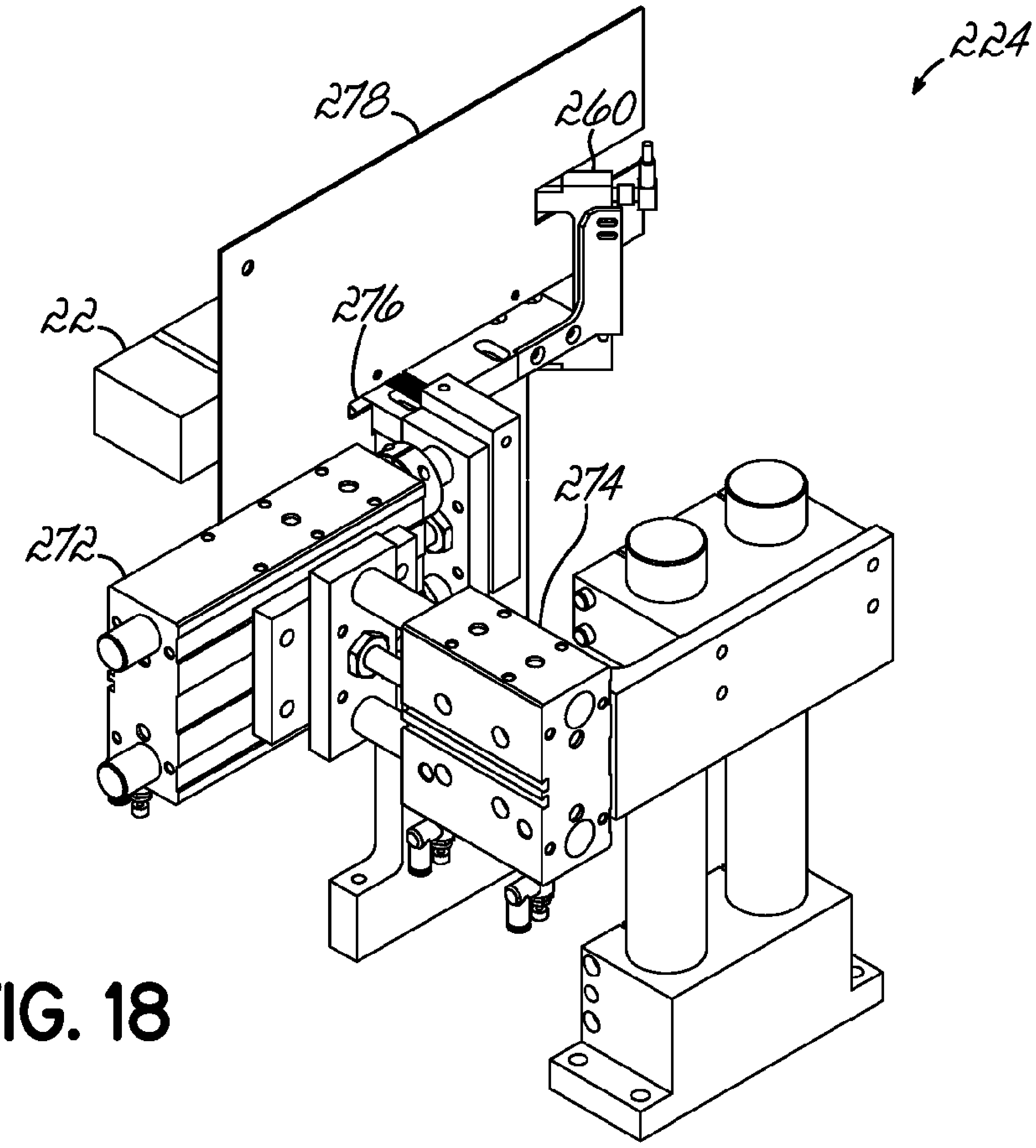

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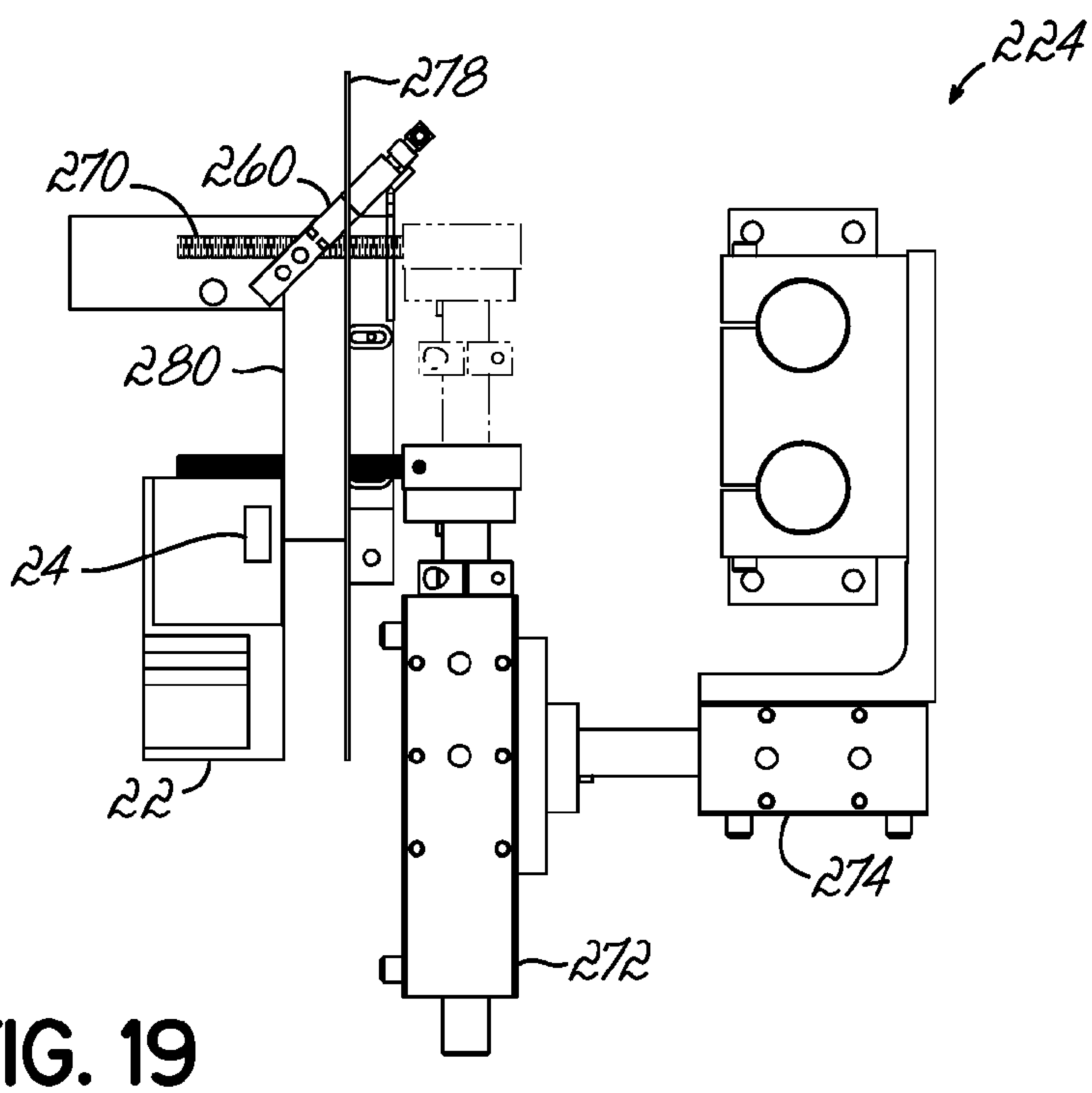

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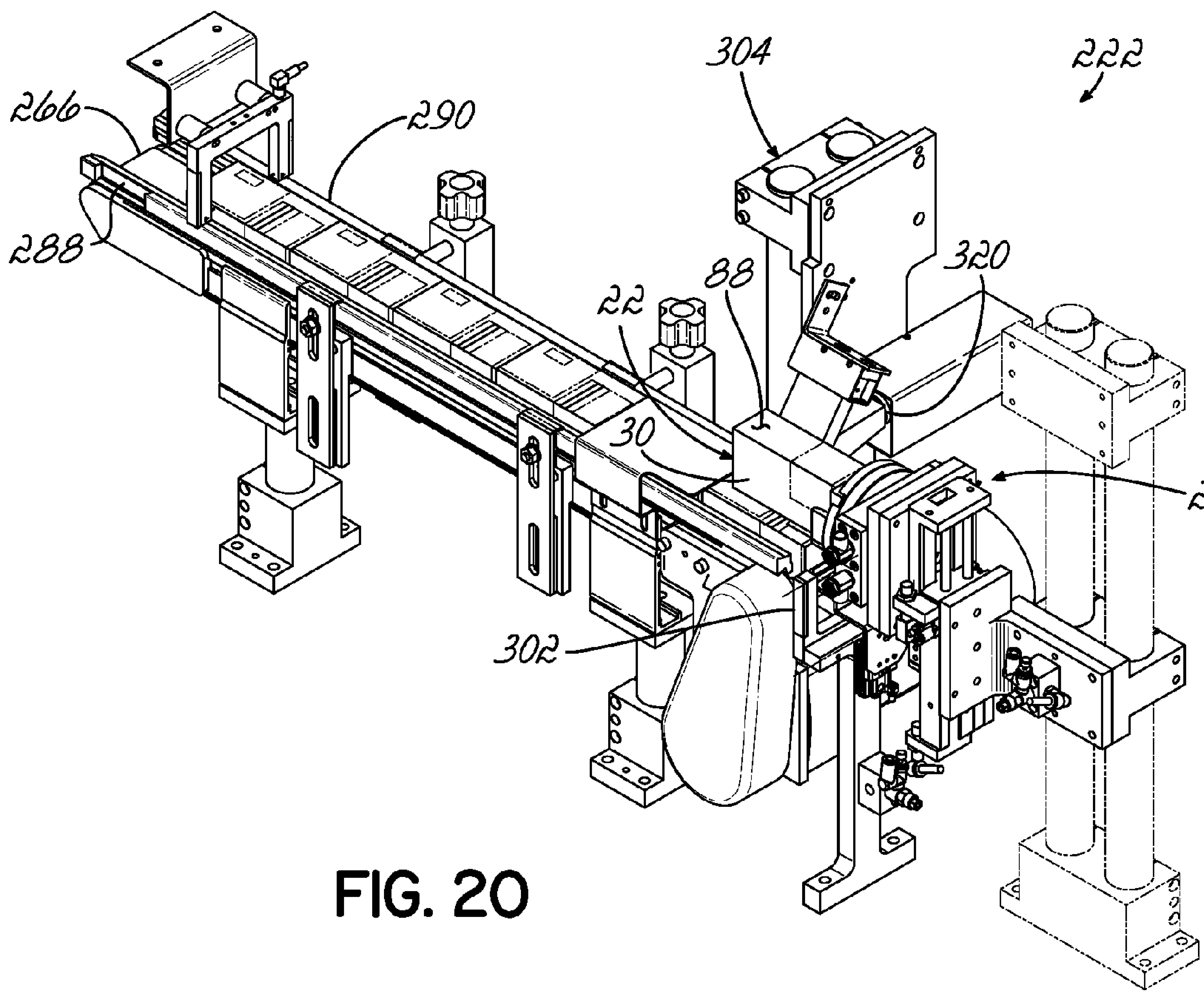
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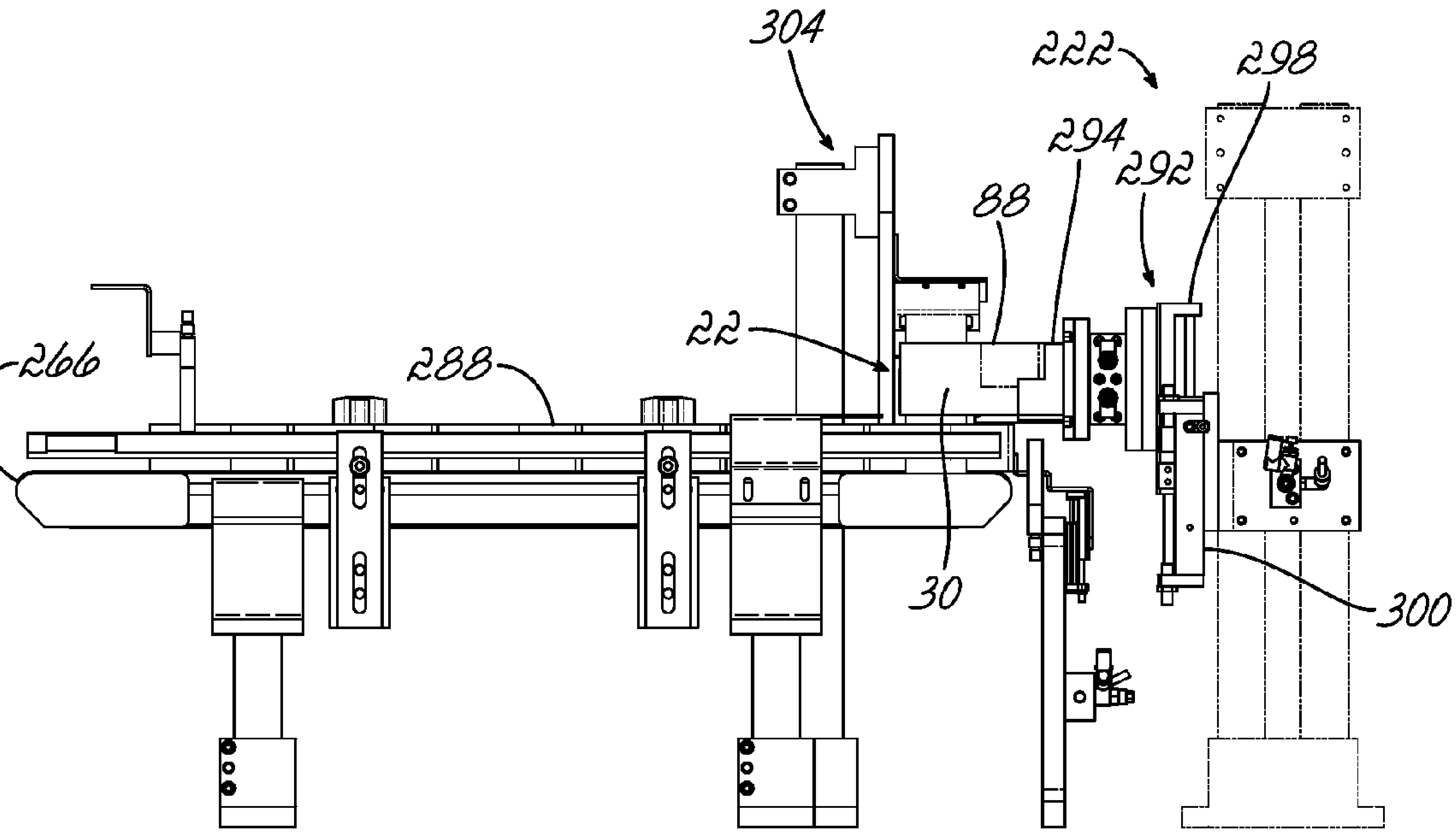
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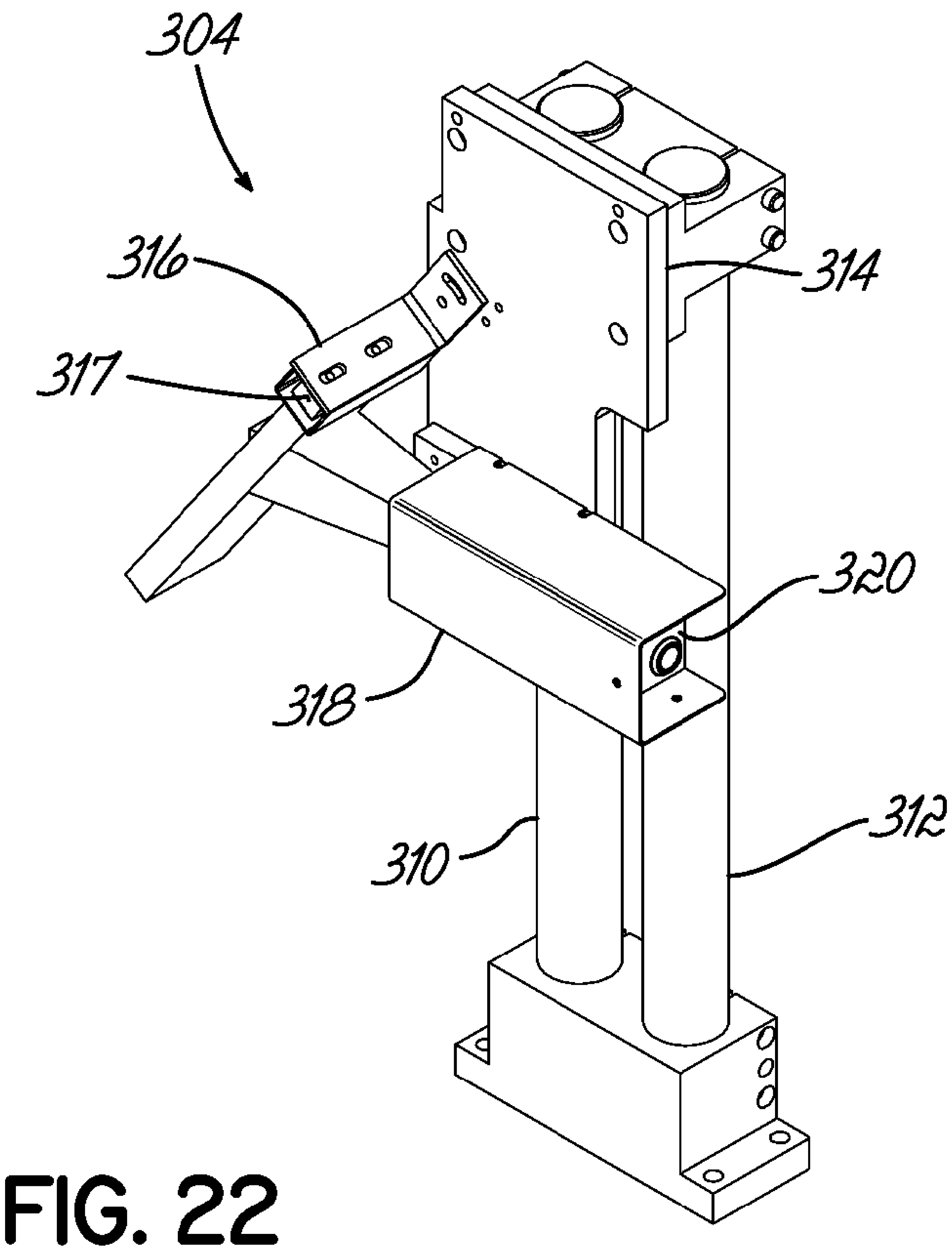

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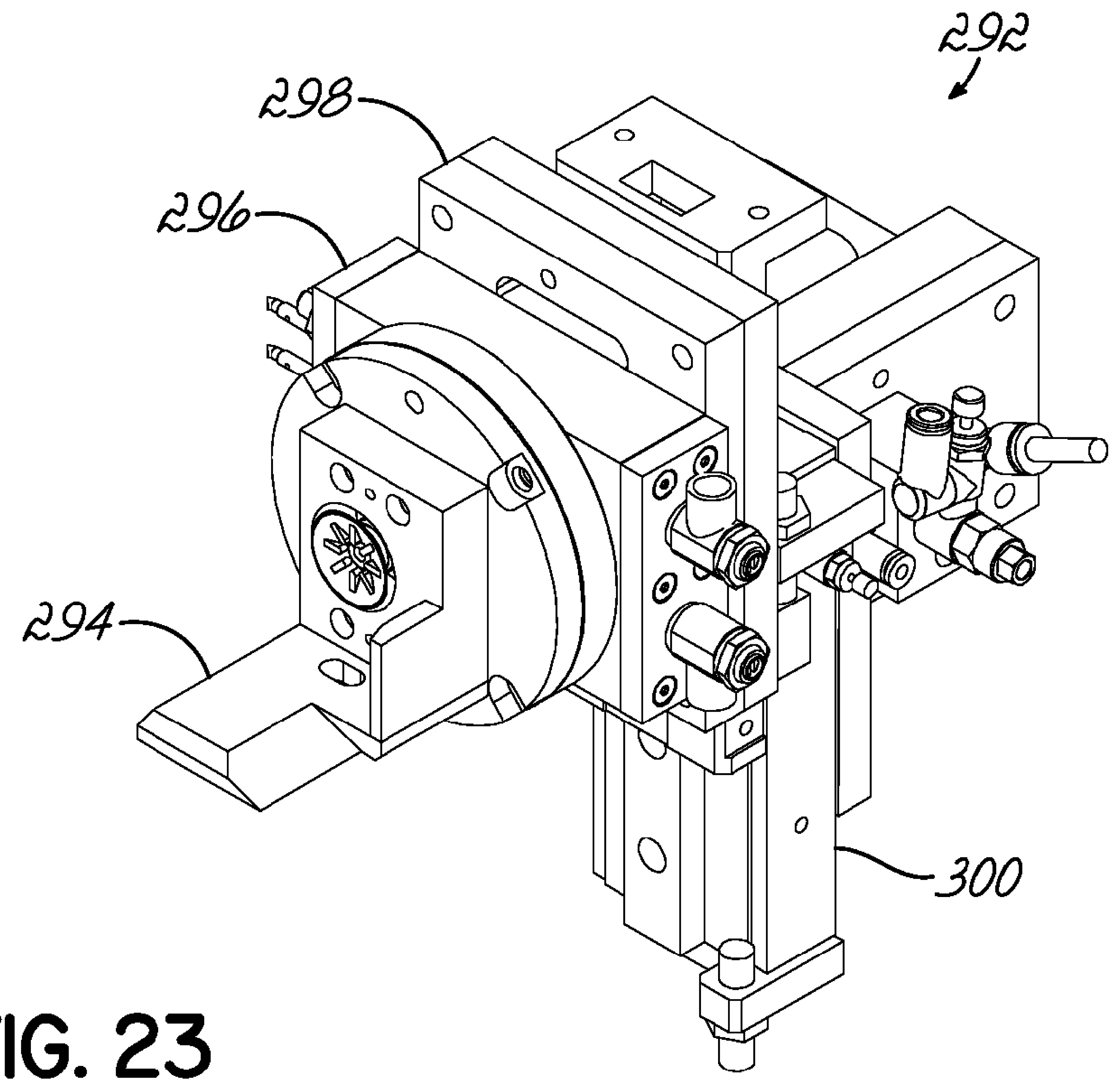

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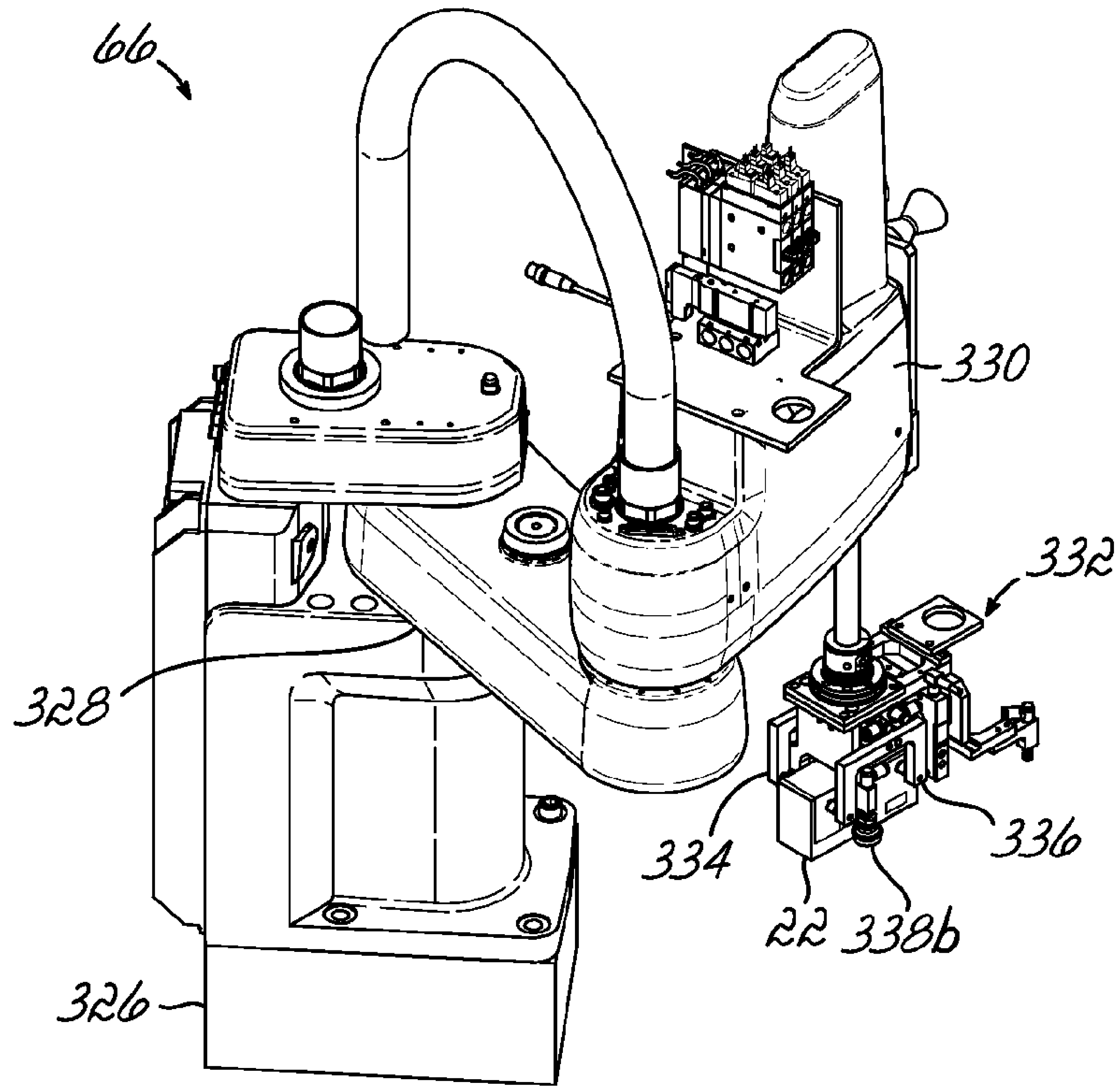
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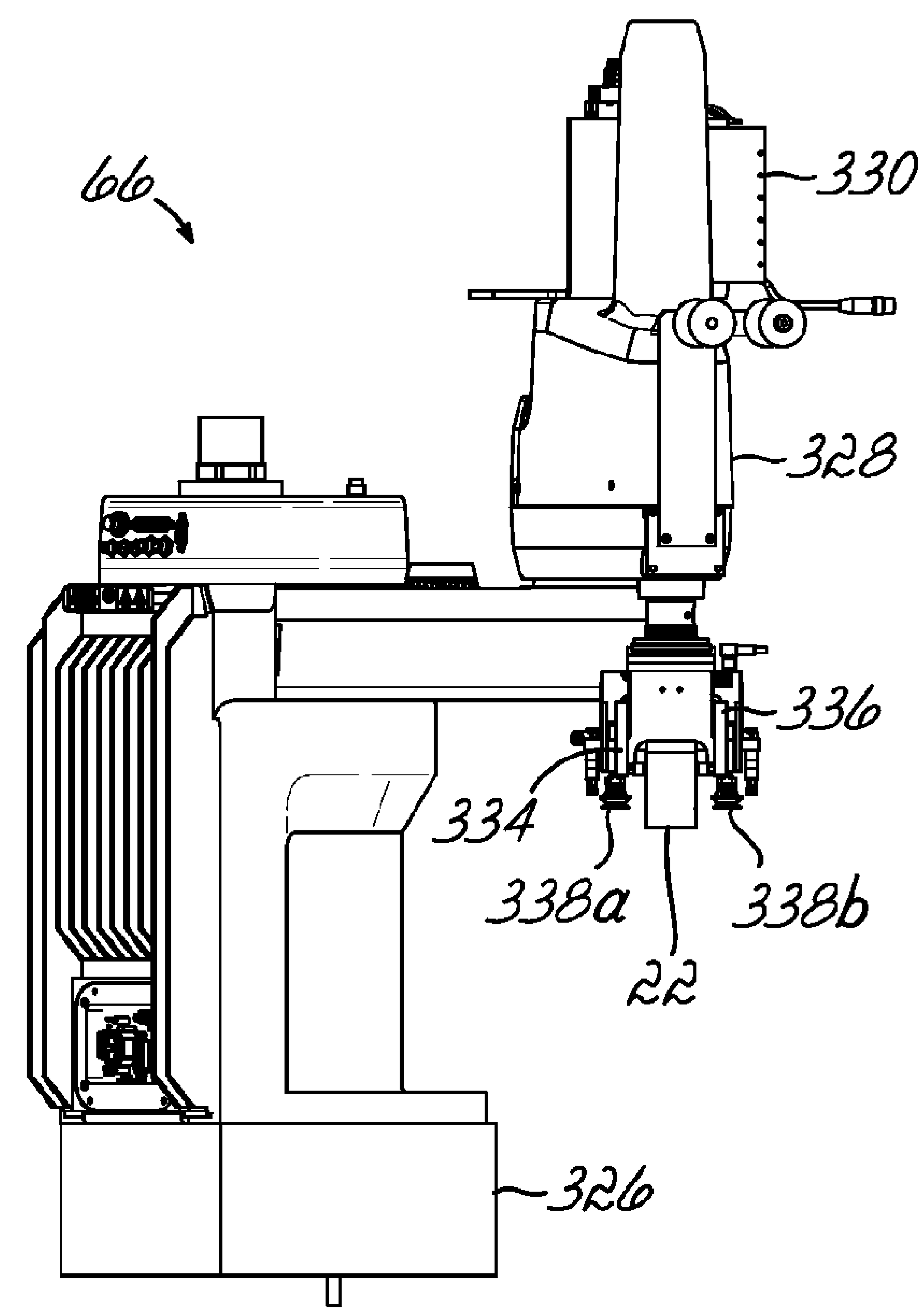
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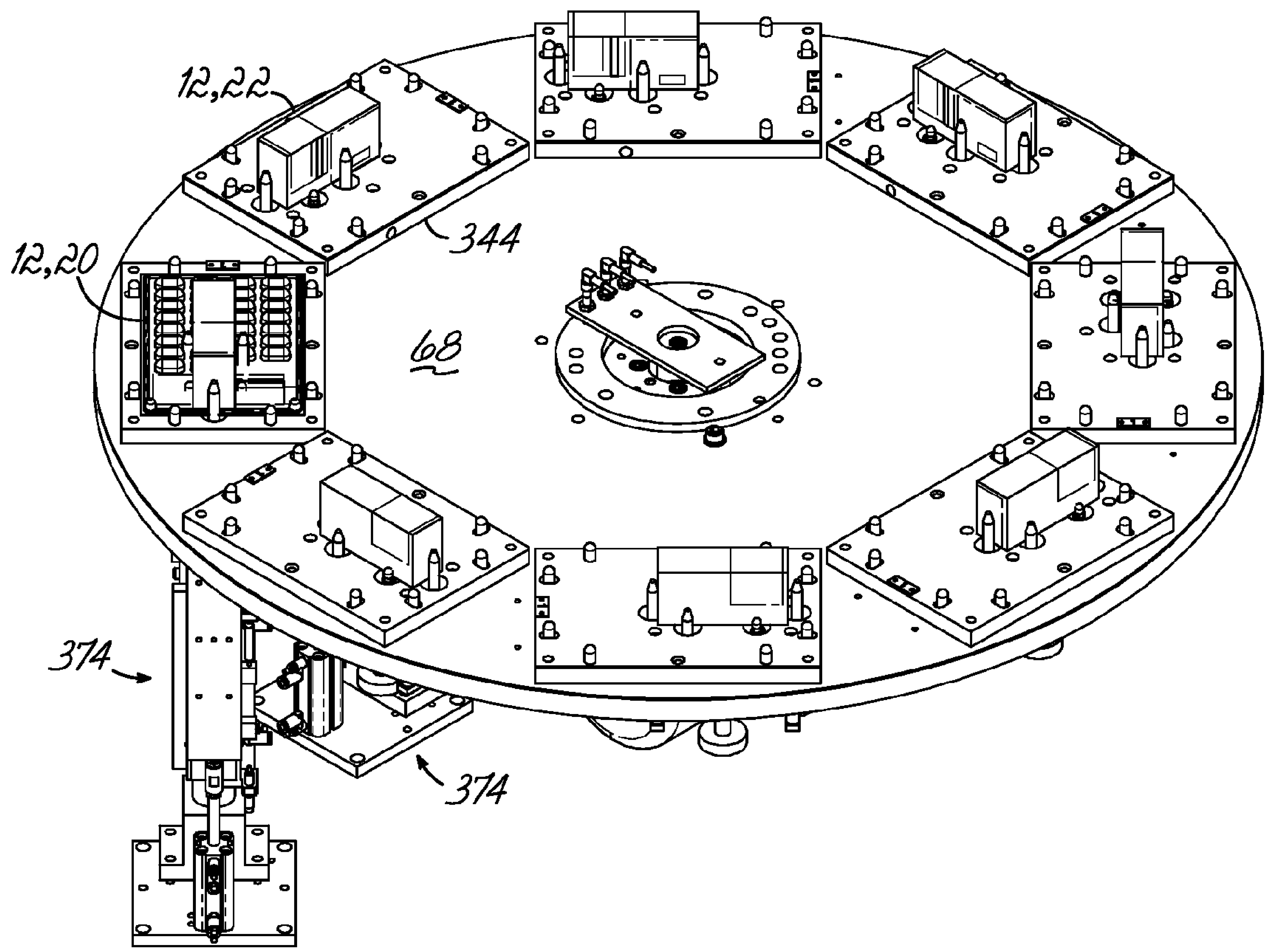
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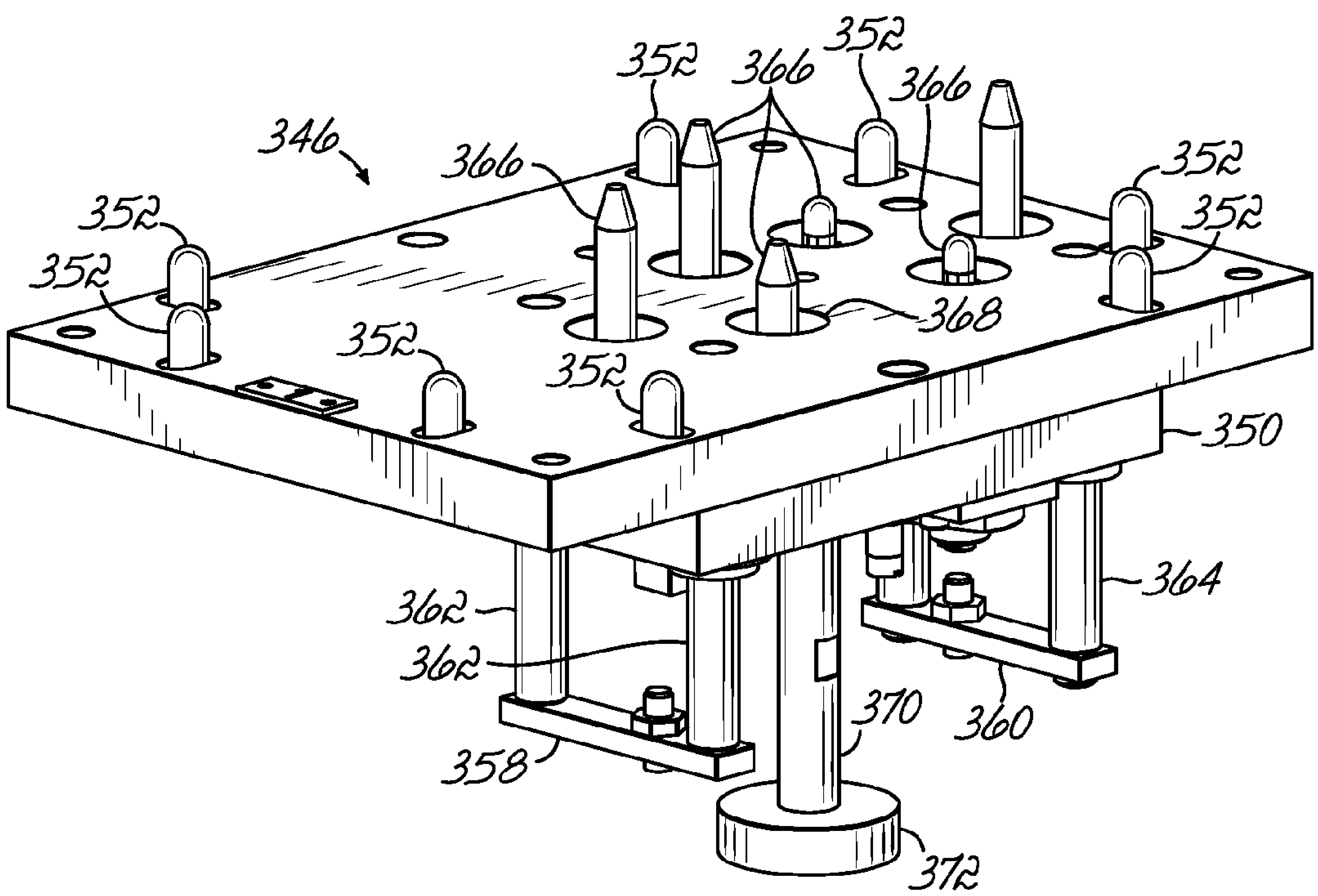
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FIG. 27

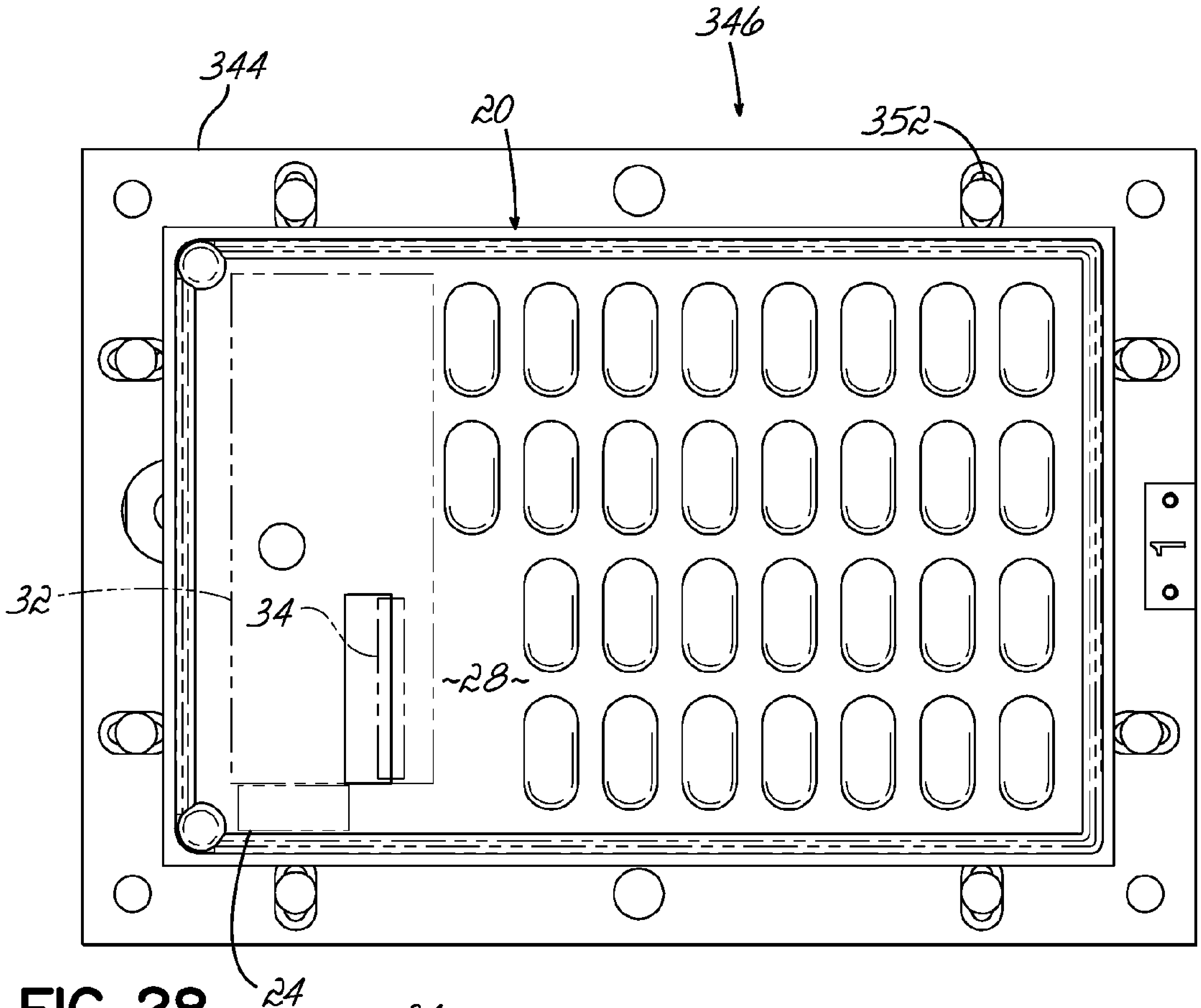
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FIG. 28

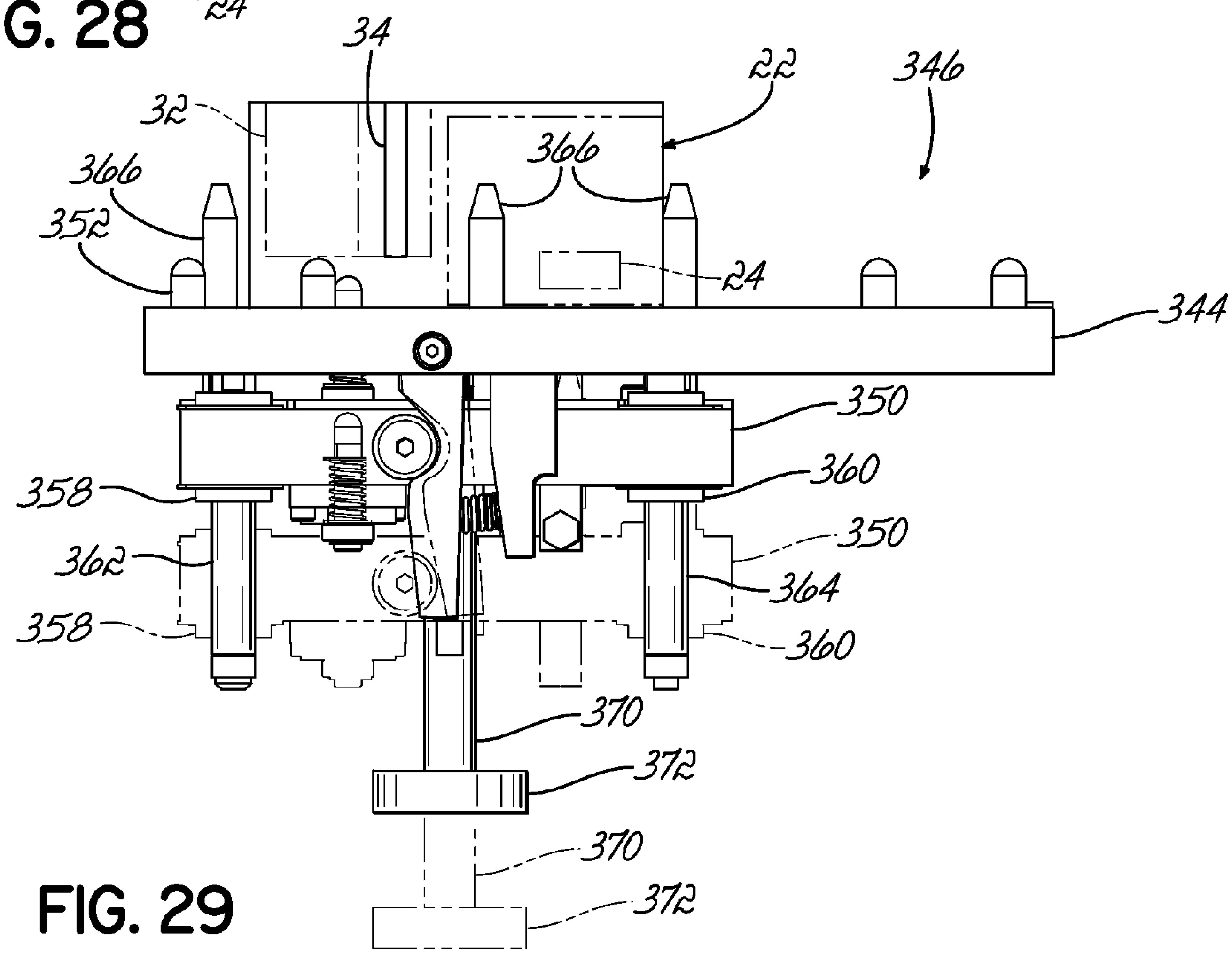
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FIG. 29

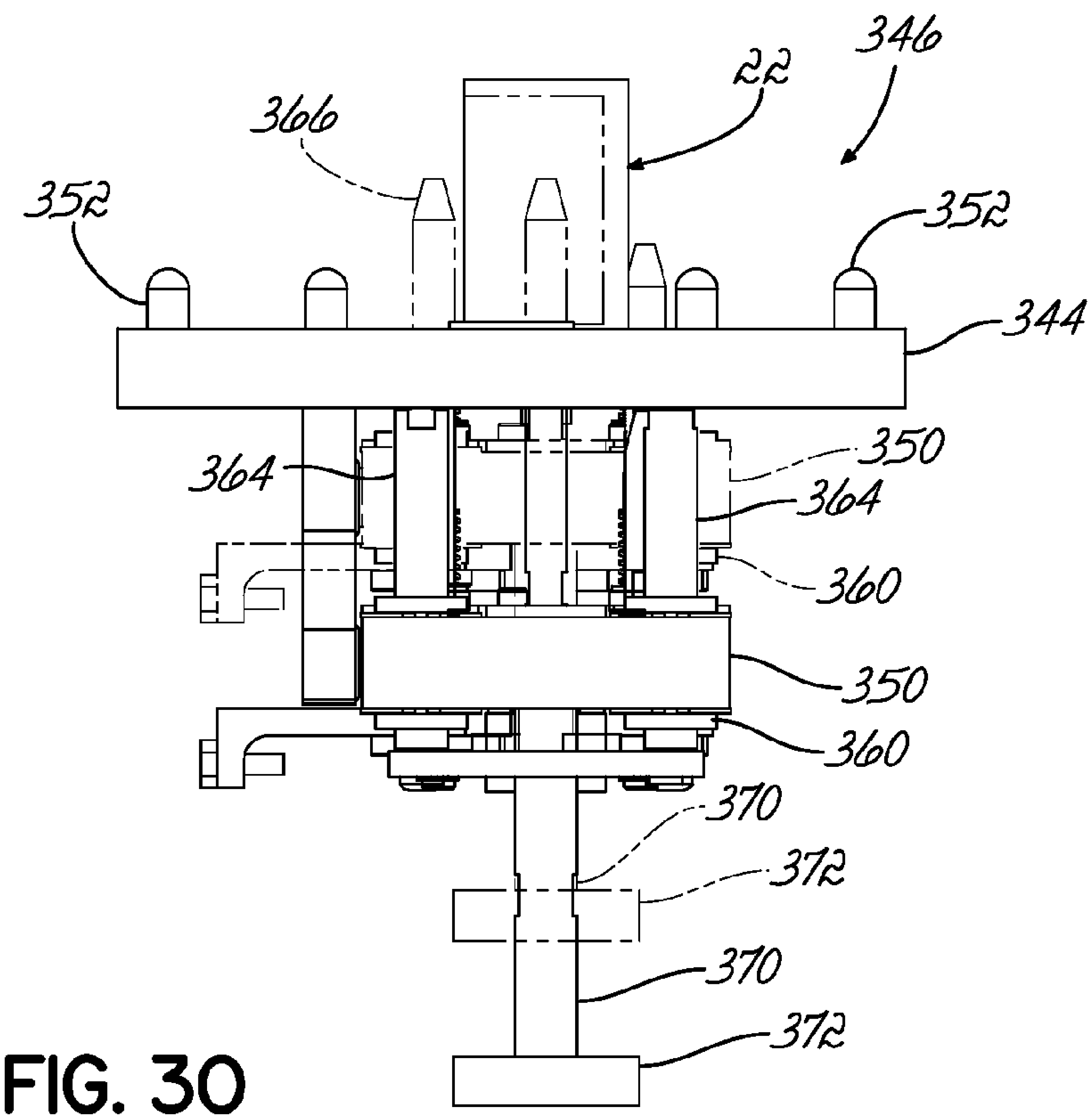
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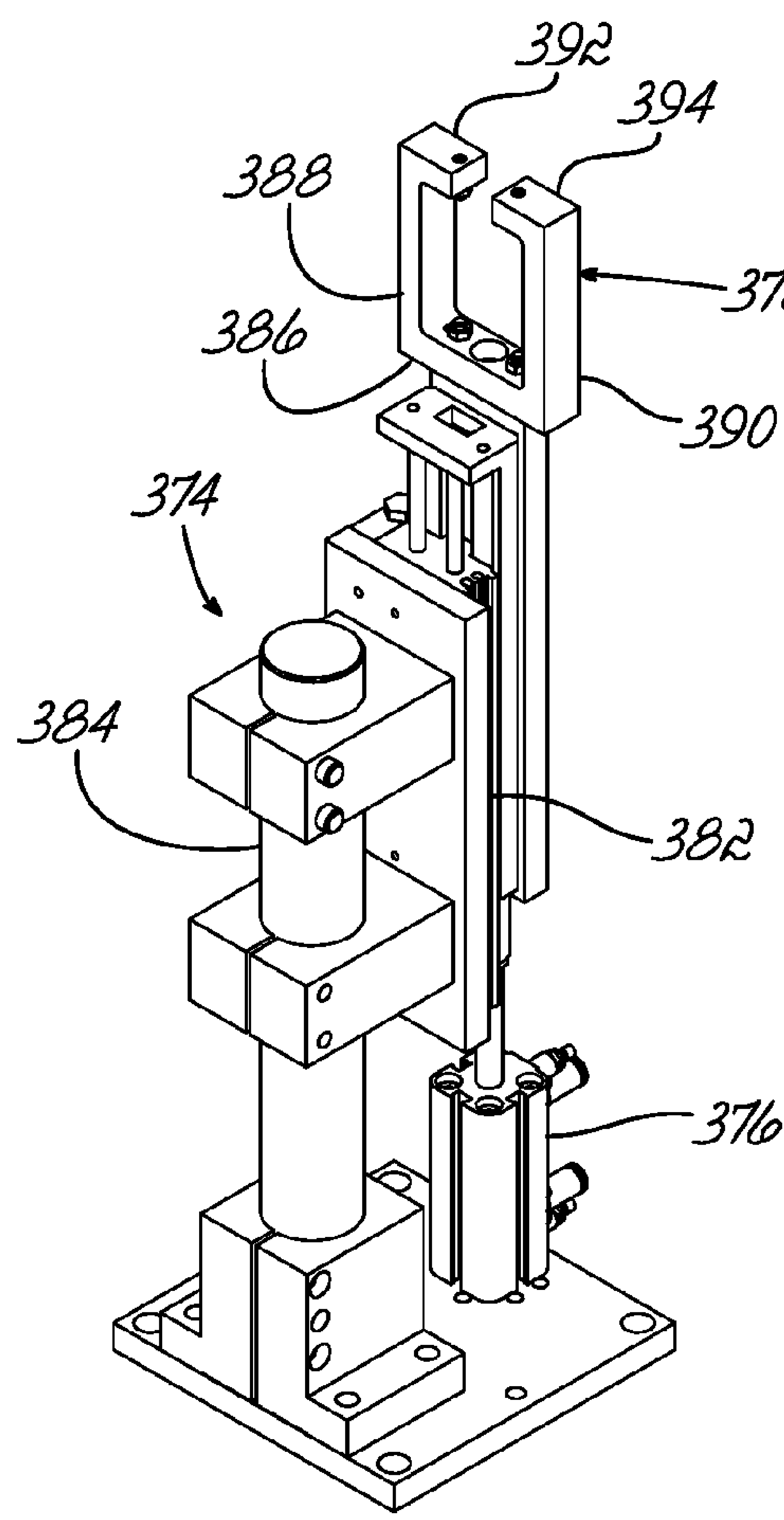
FIG. 30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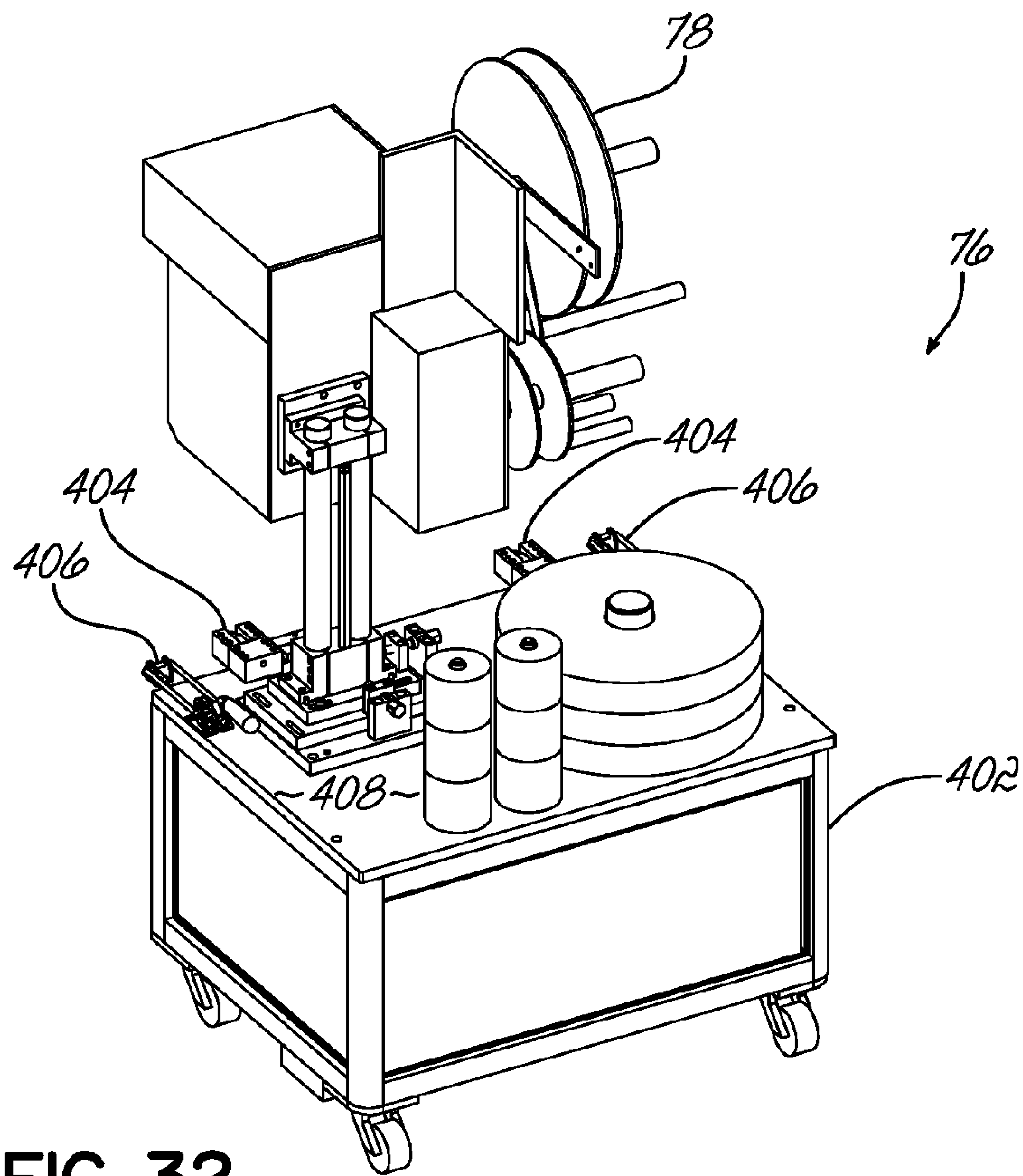

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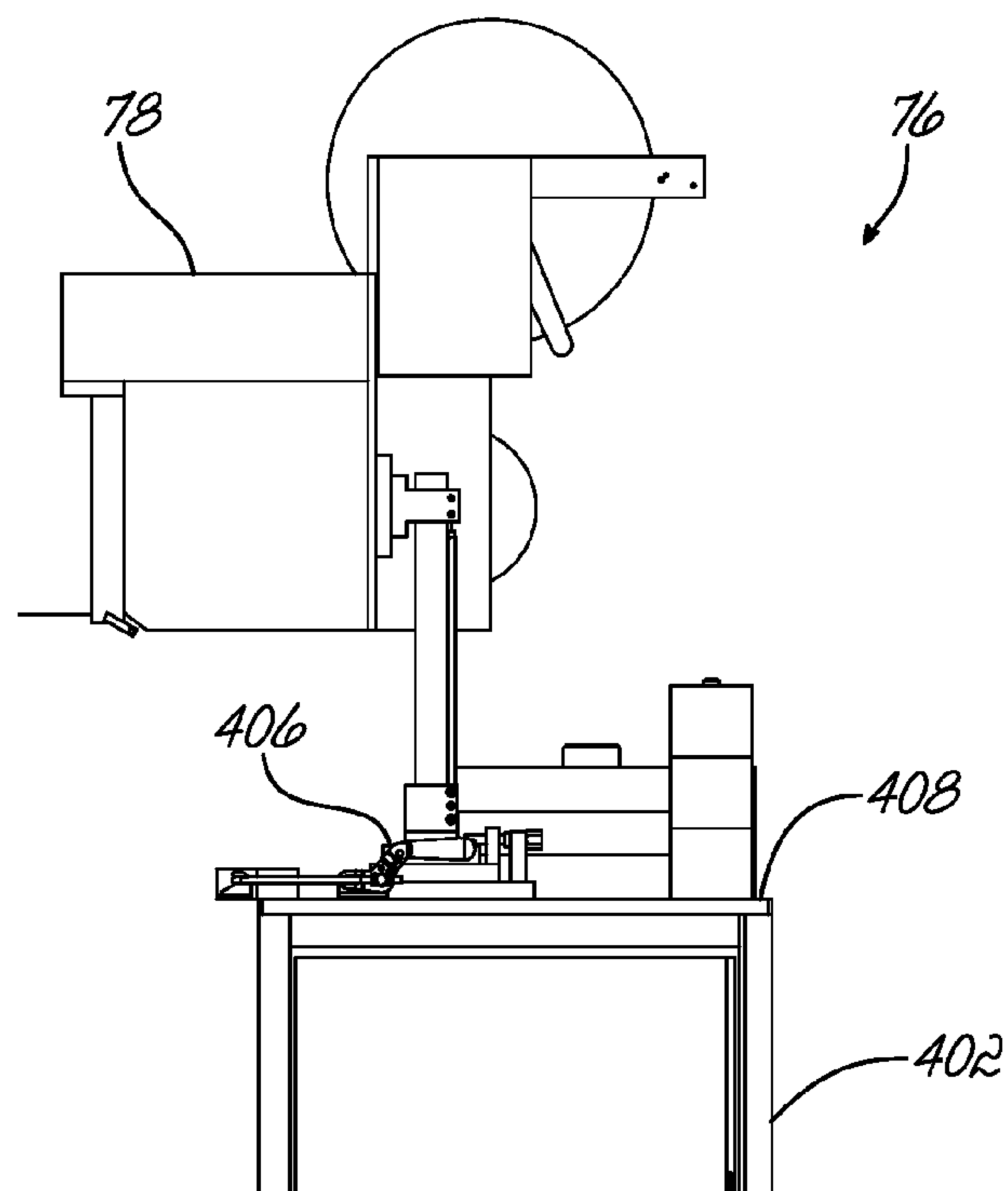

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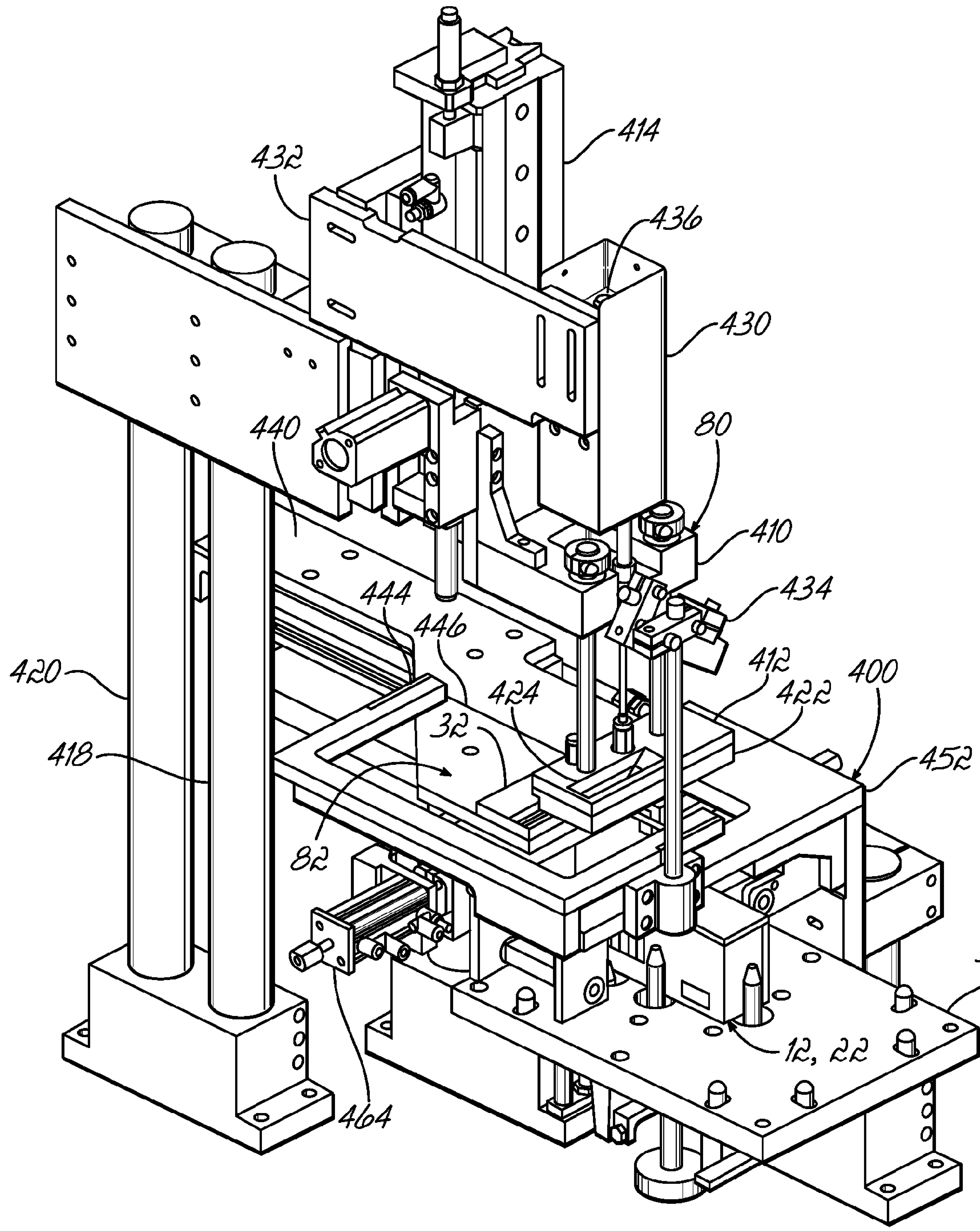
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FIG. 34

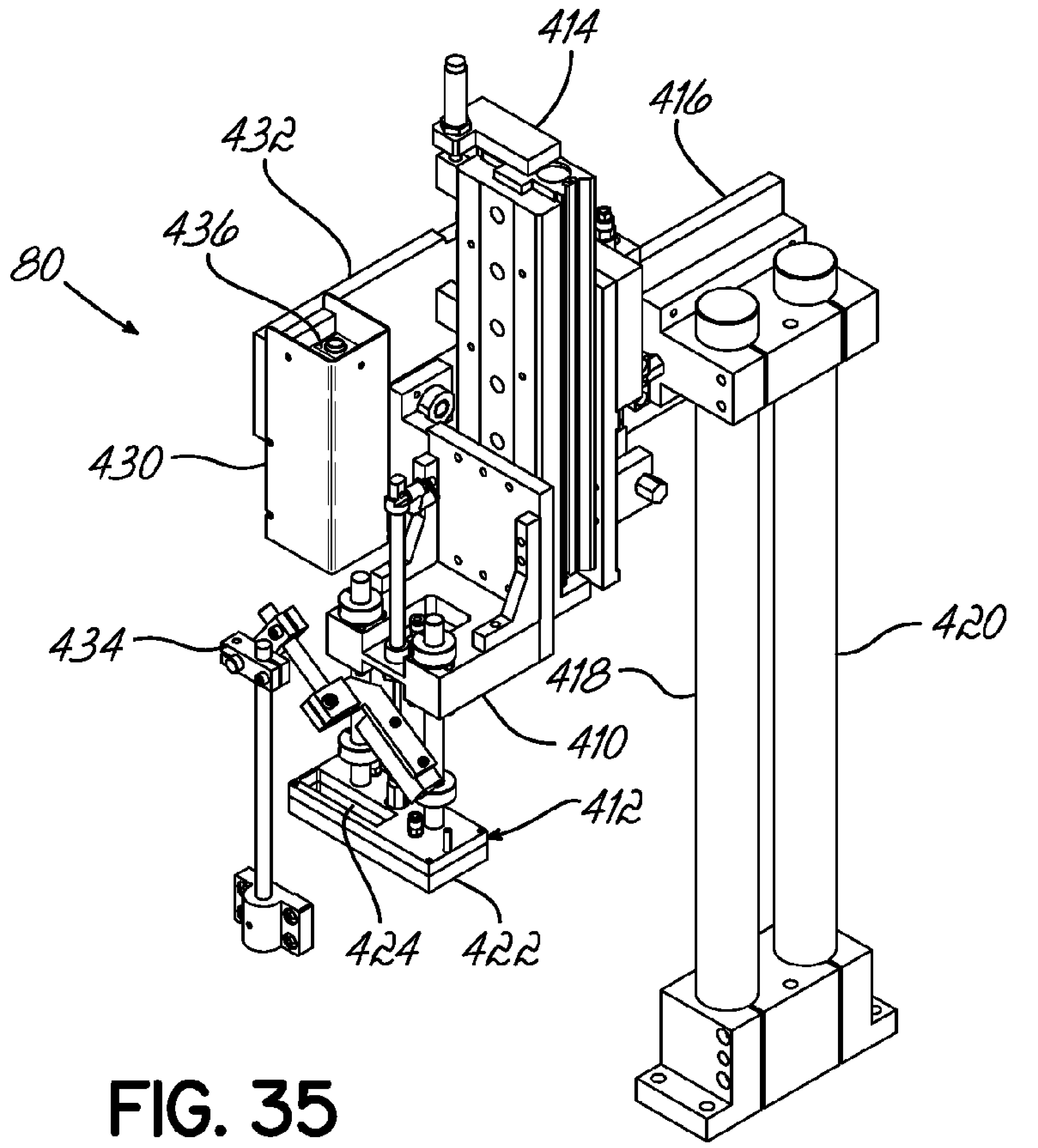
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FIG. 35

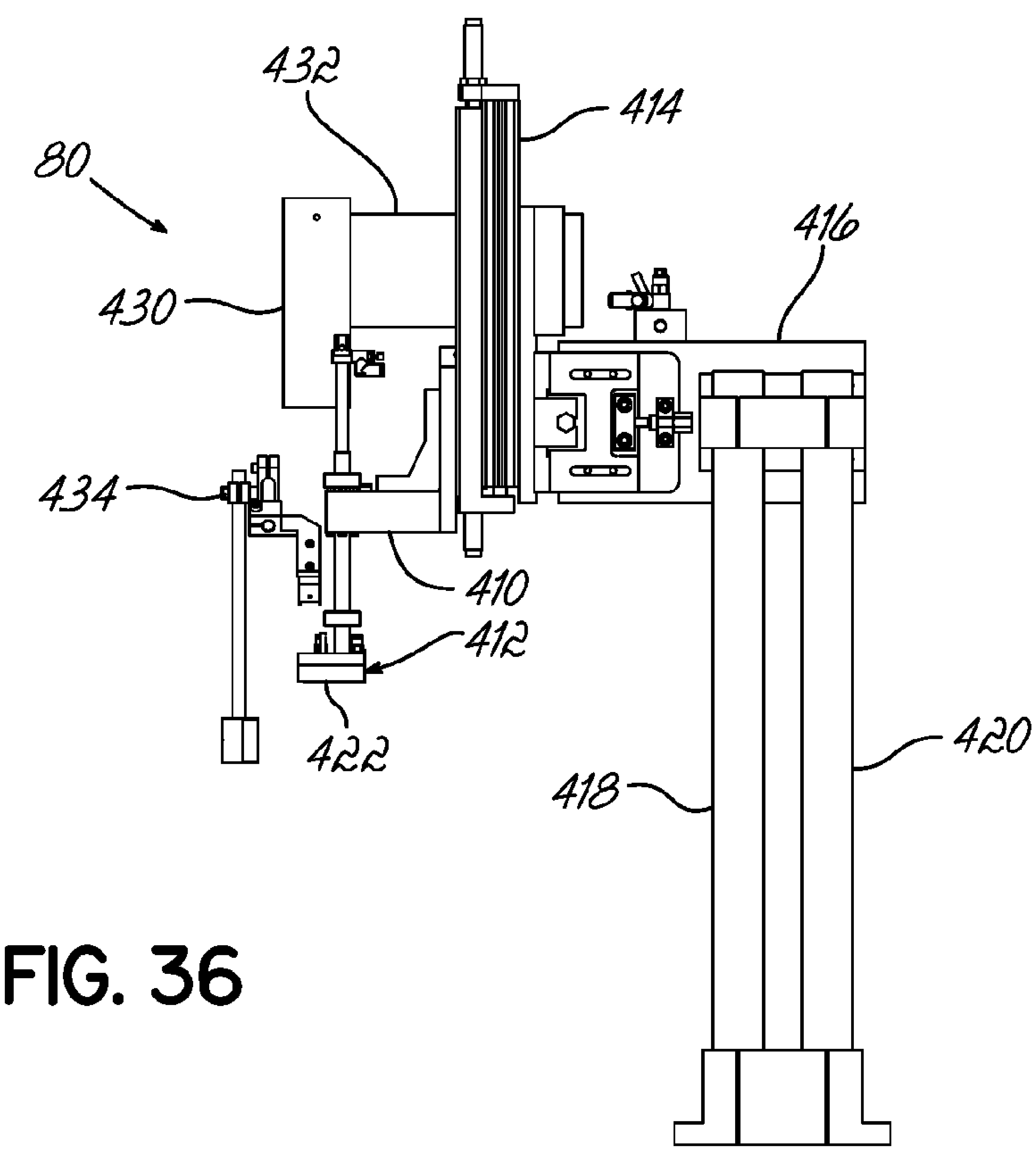
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FIG. 36

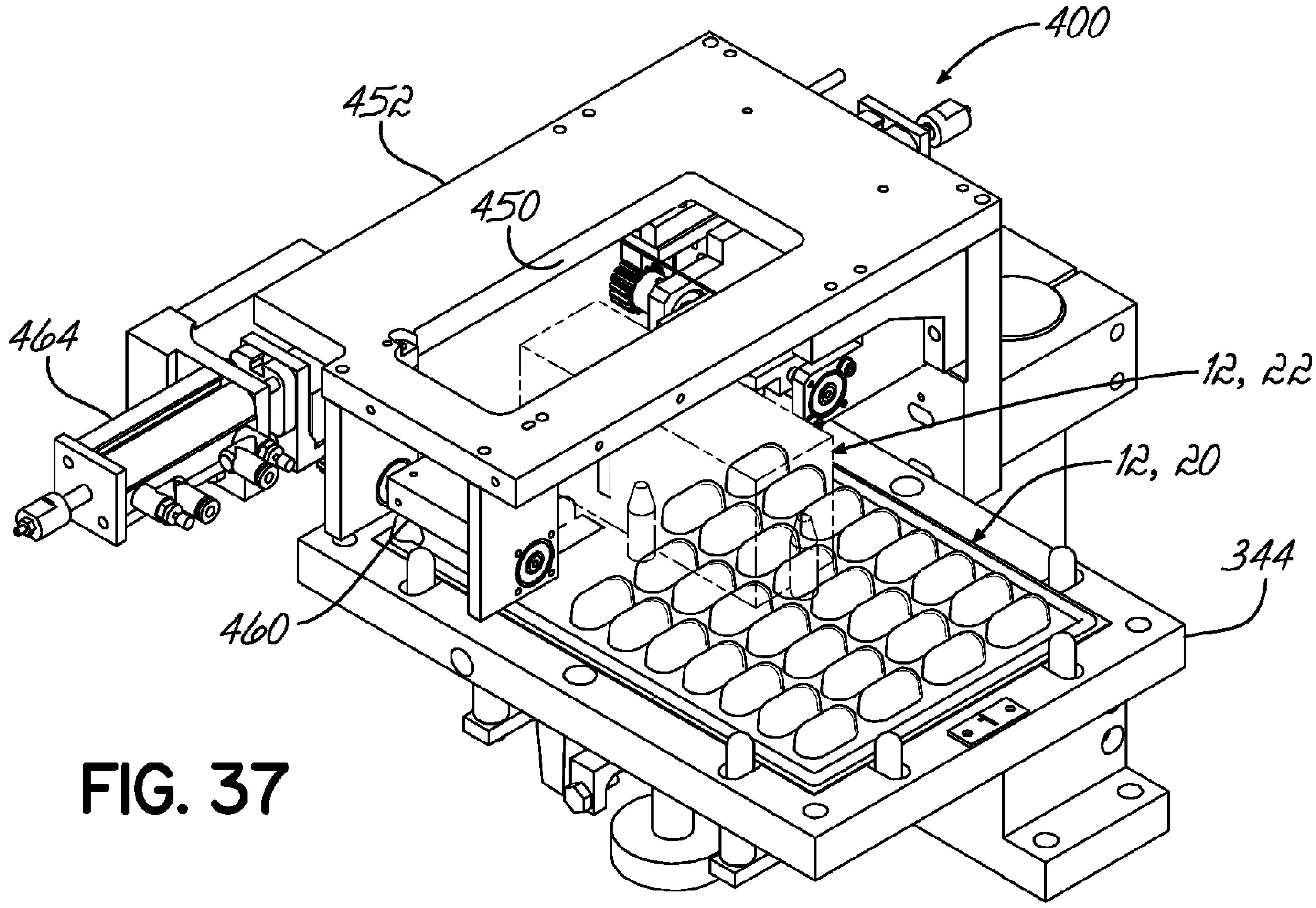
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FIG. 37

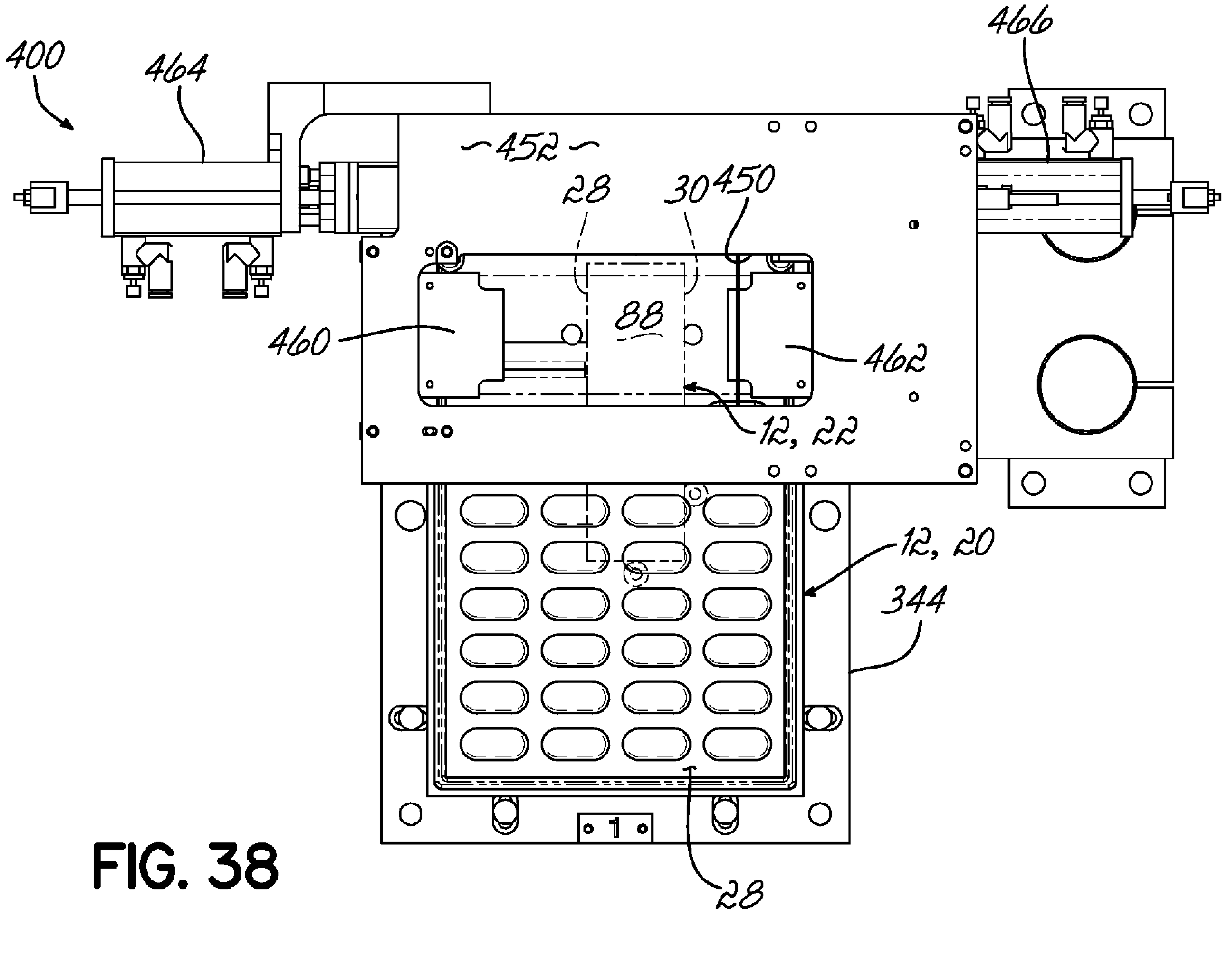
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FIG. 38

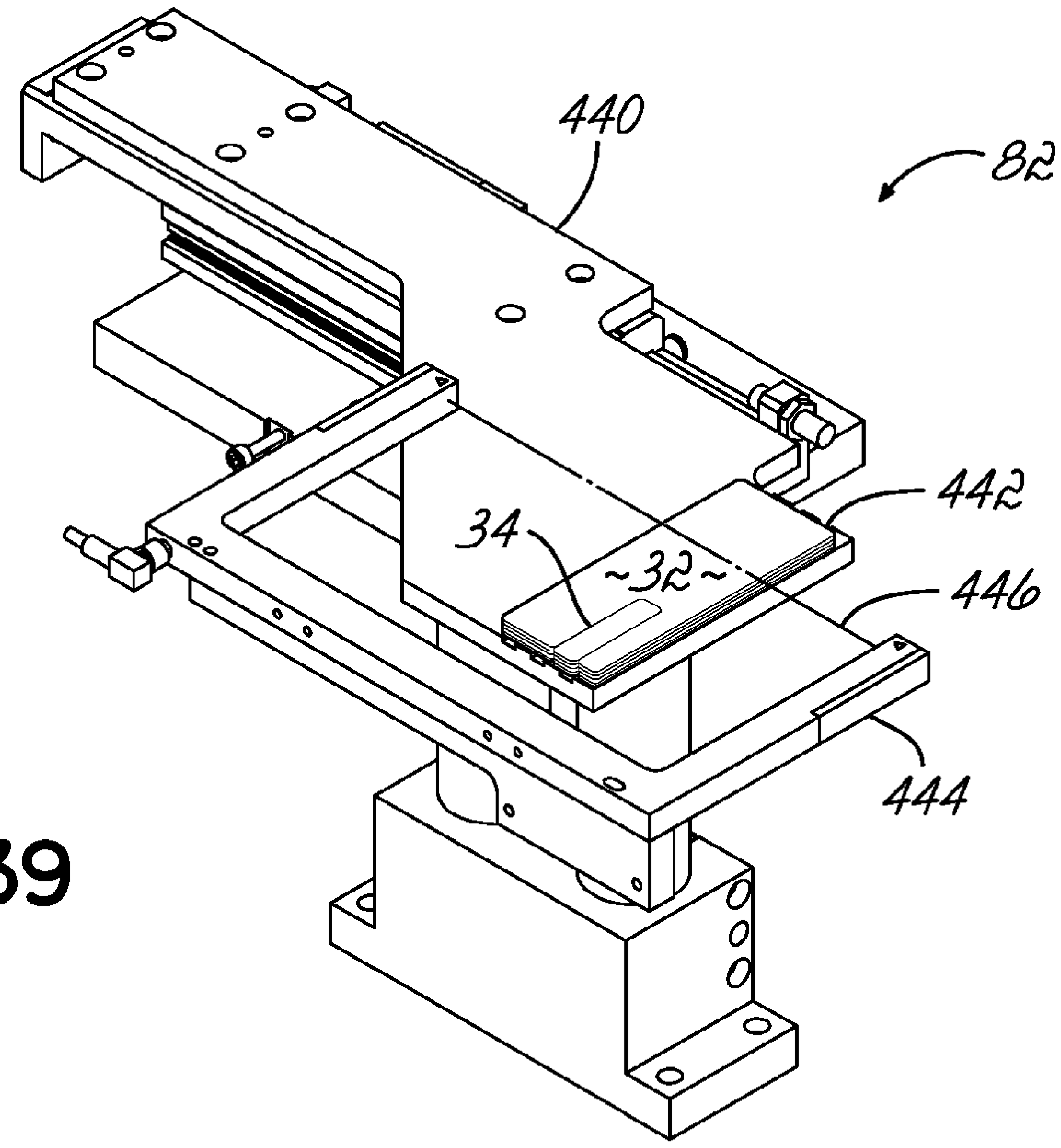

FIG. 39

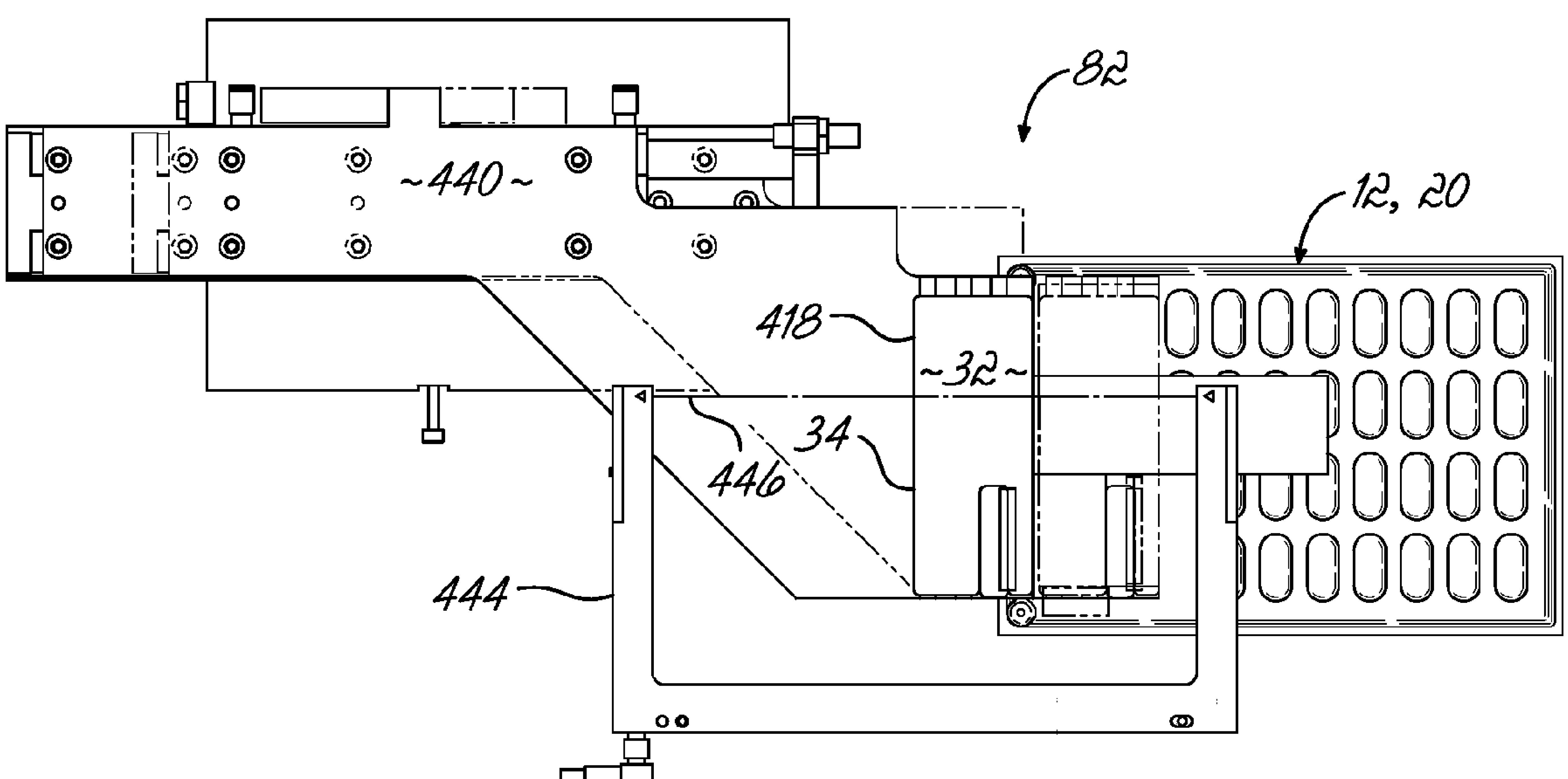

FIG. 40

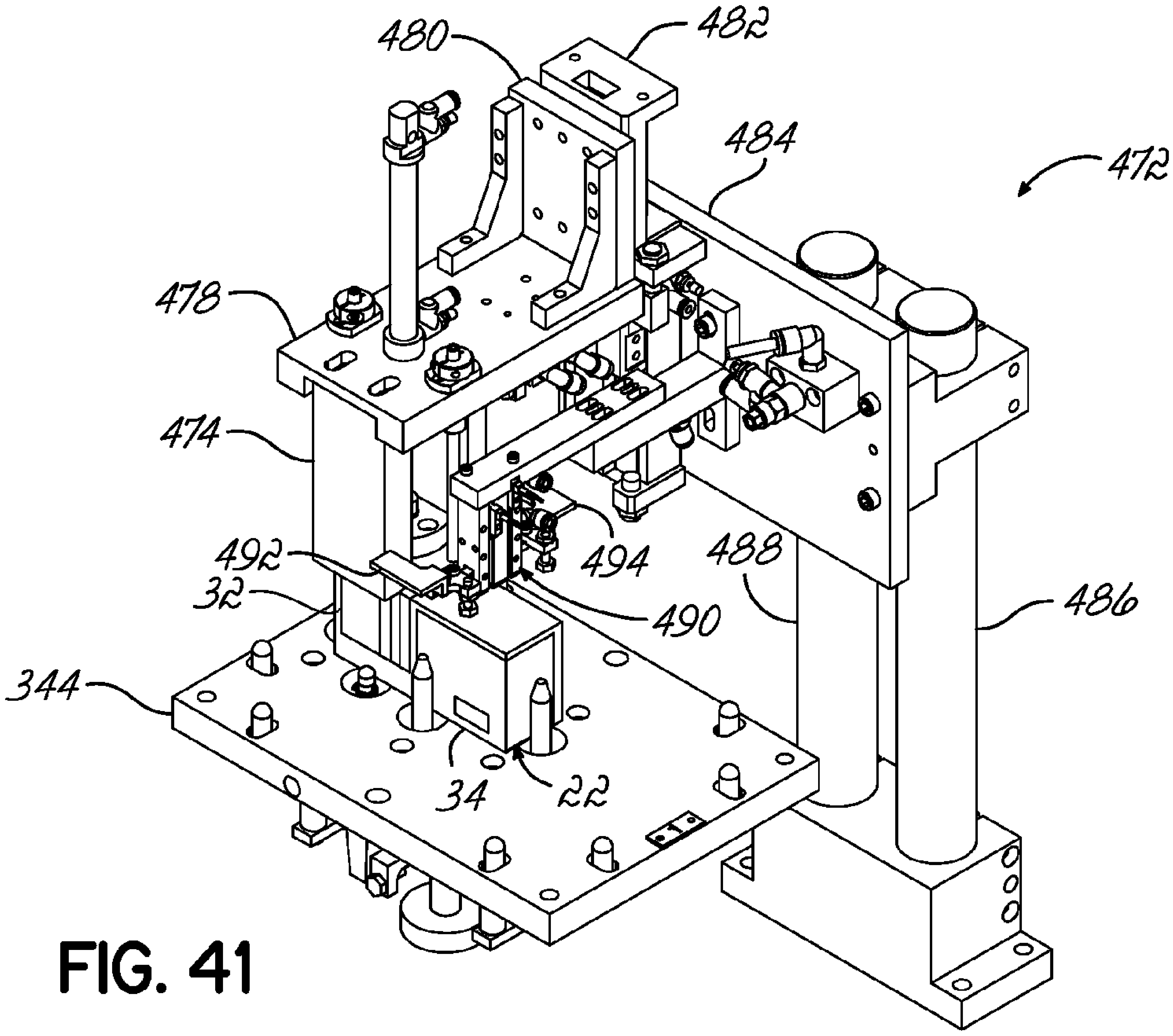
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FIG. 41

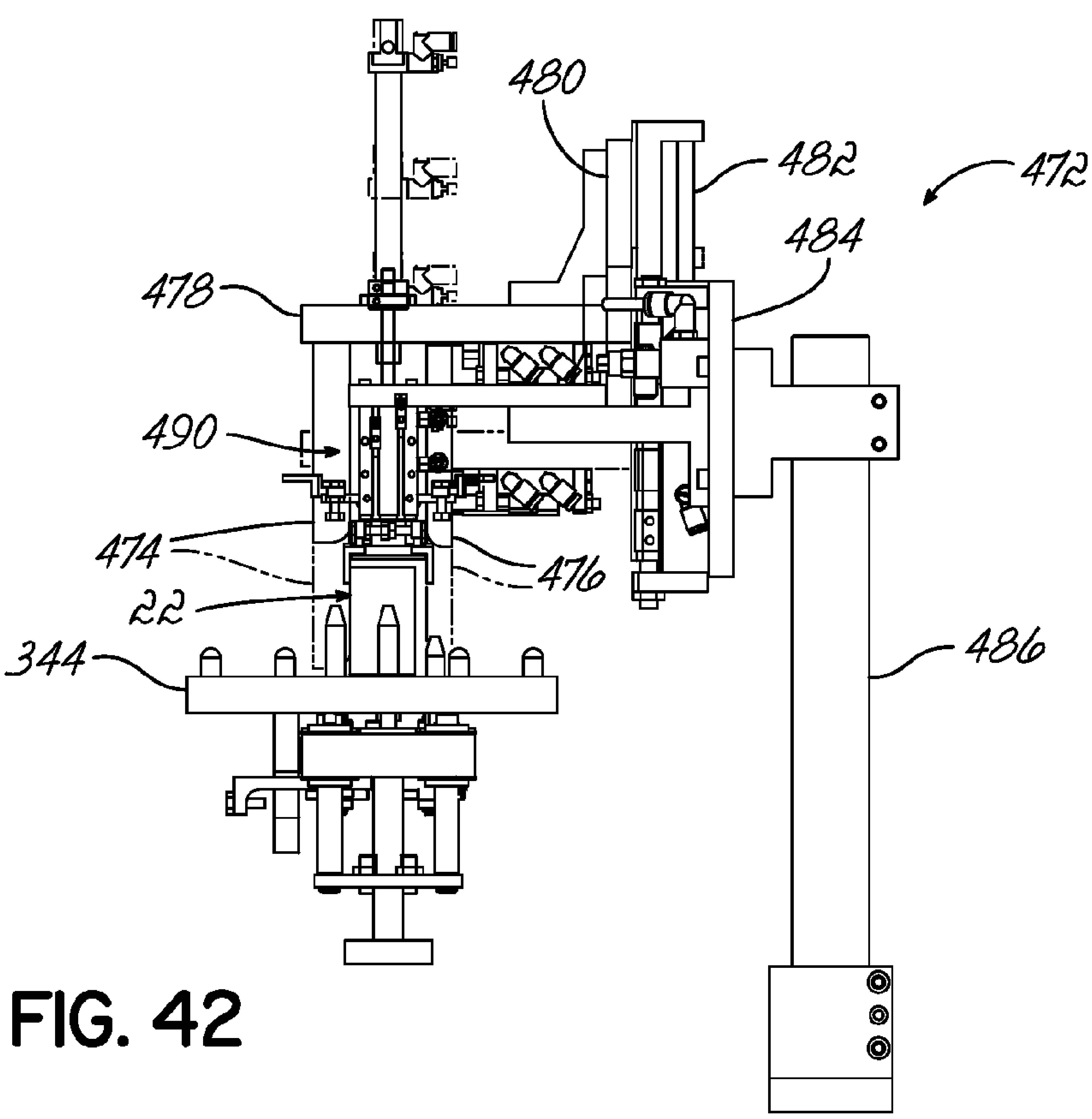
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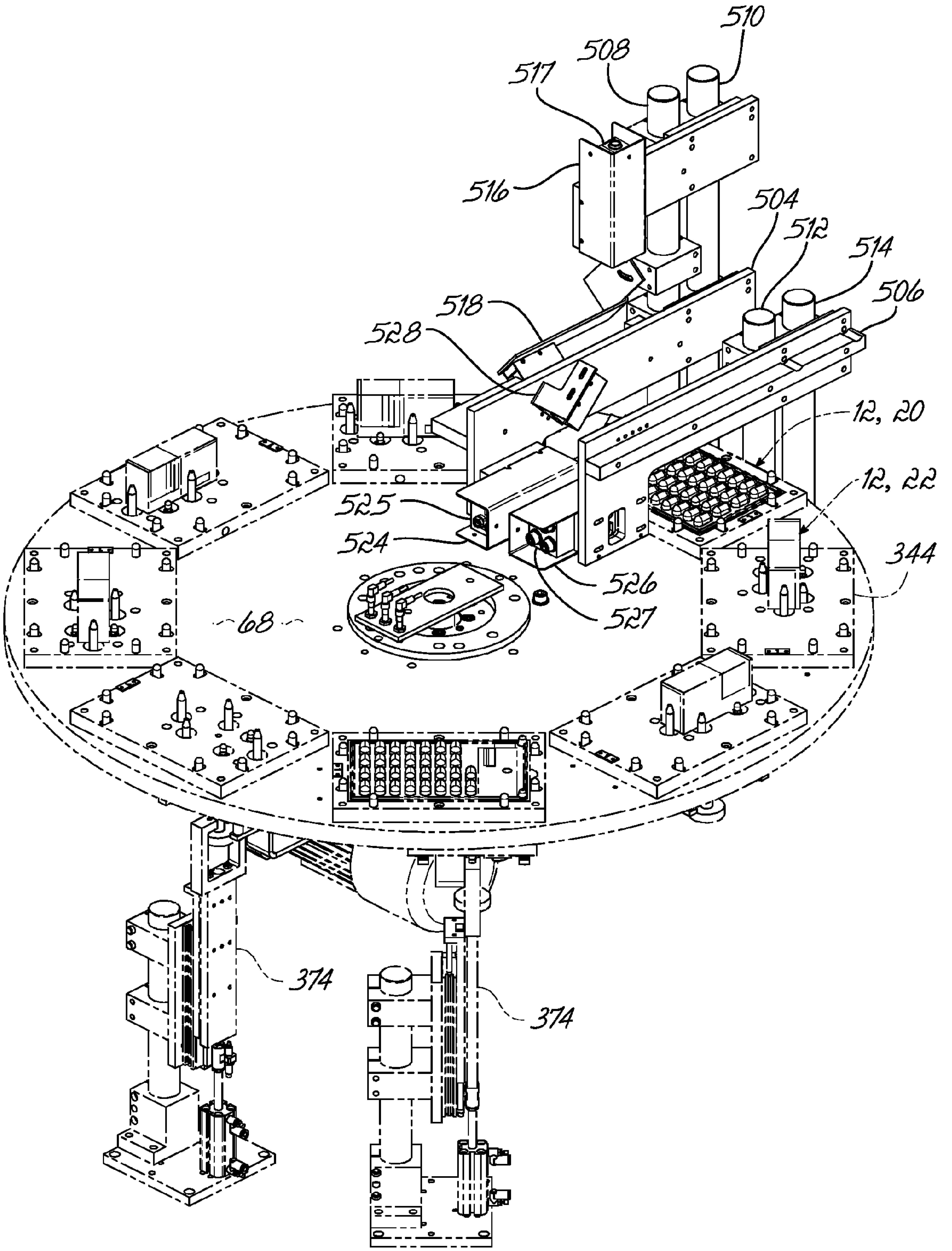
FIG. 42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374

FIG. 43

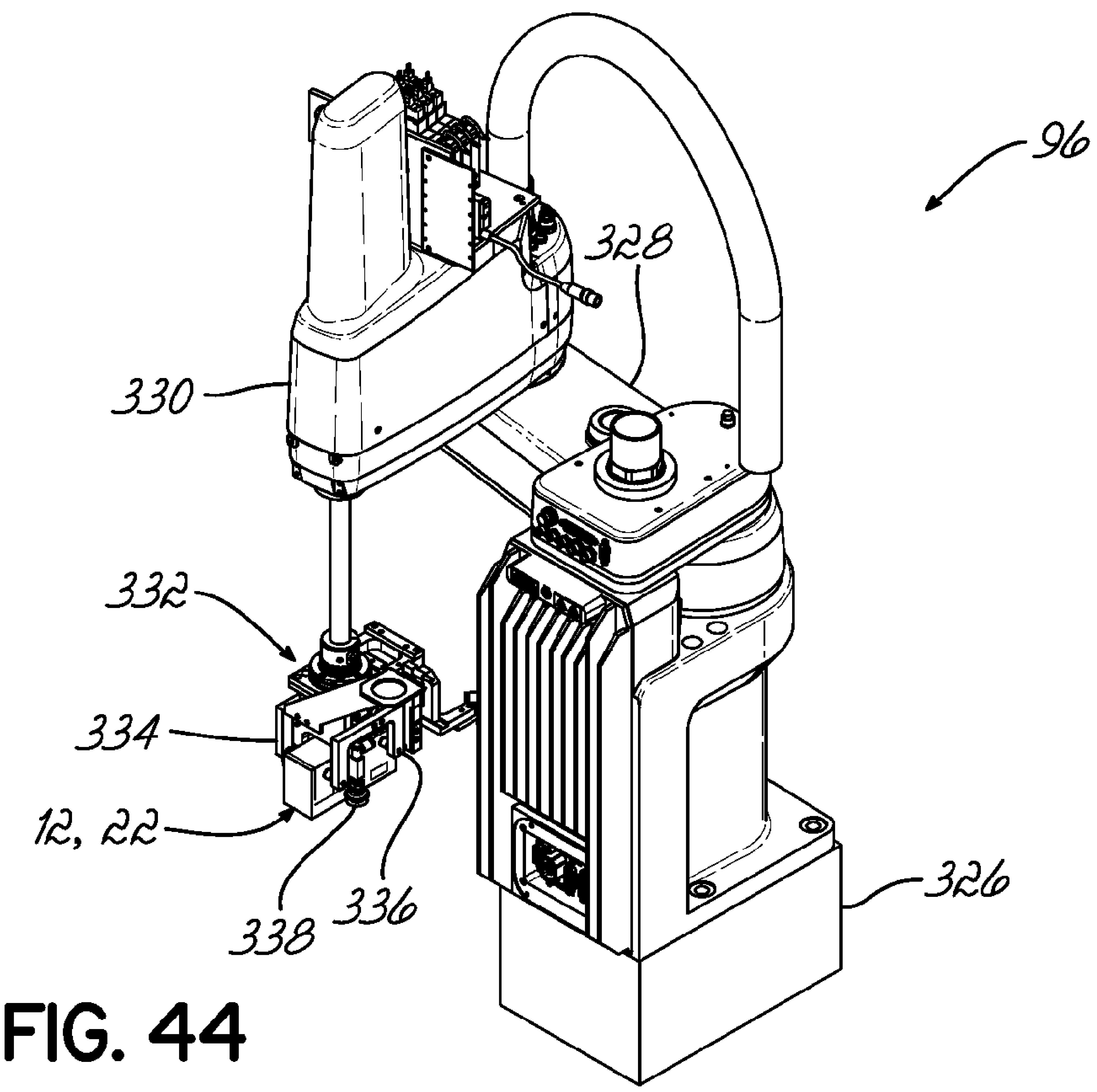

FIG. 44

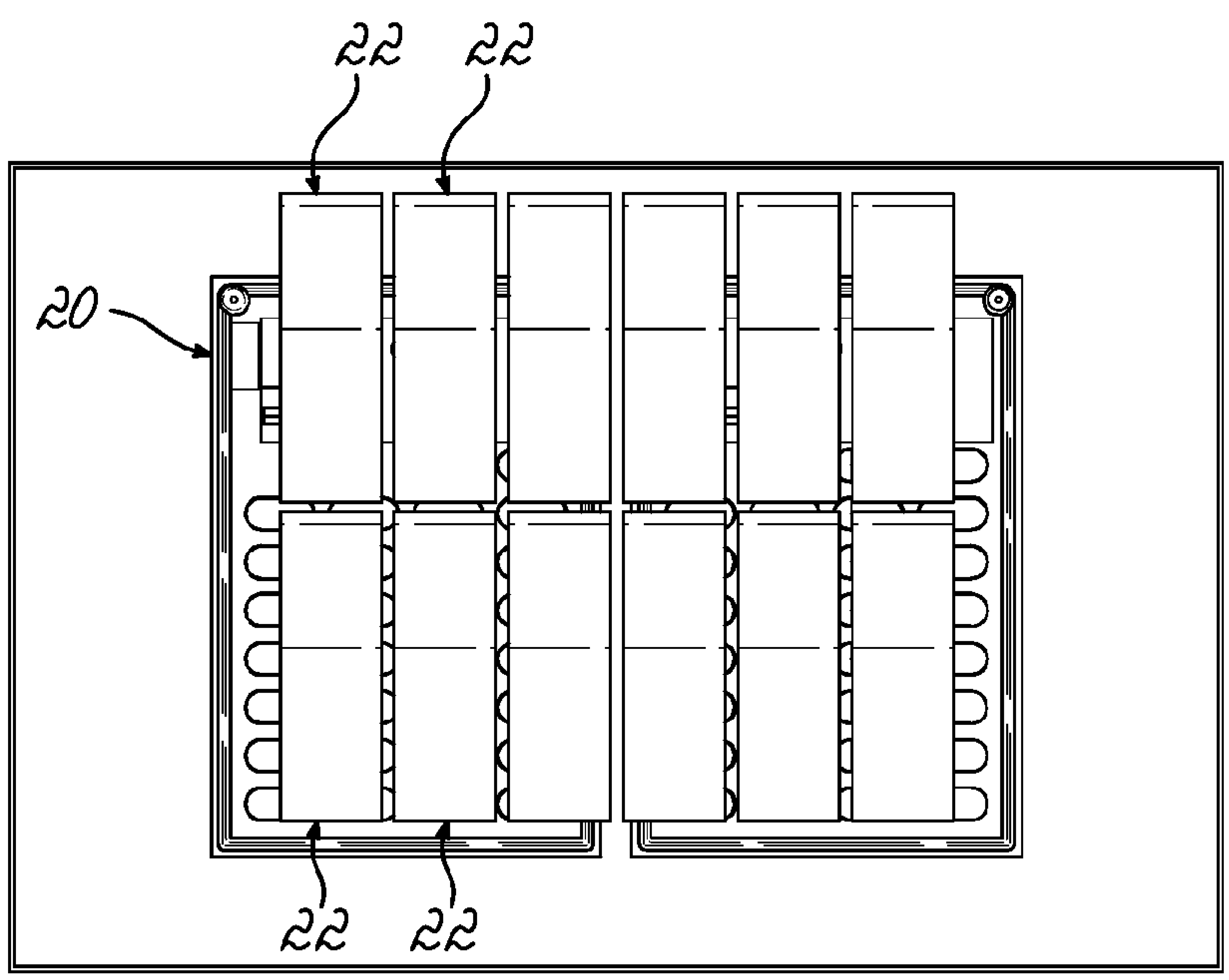

FIG. 45

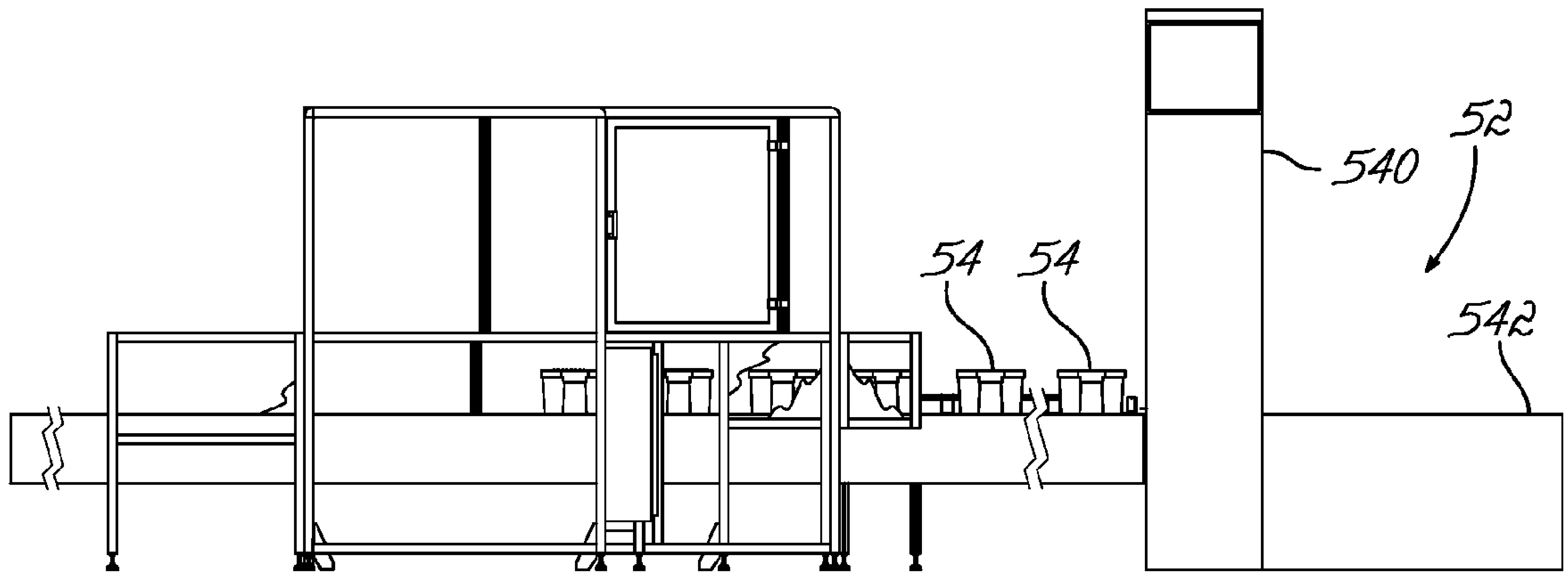

FIG. 46

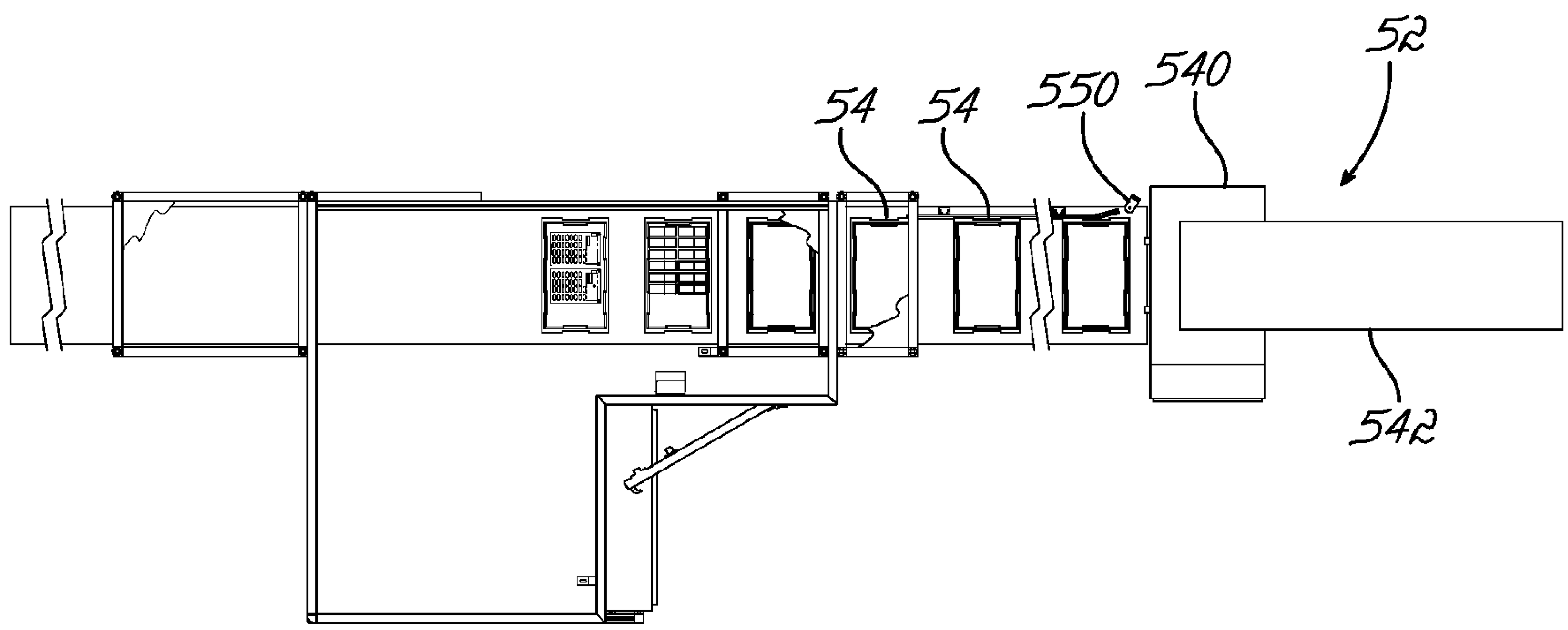

FIG. 47

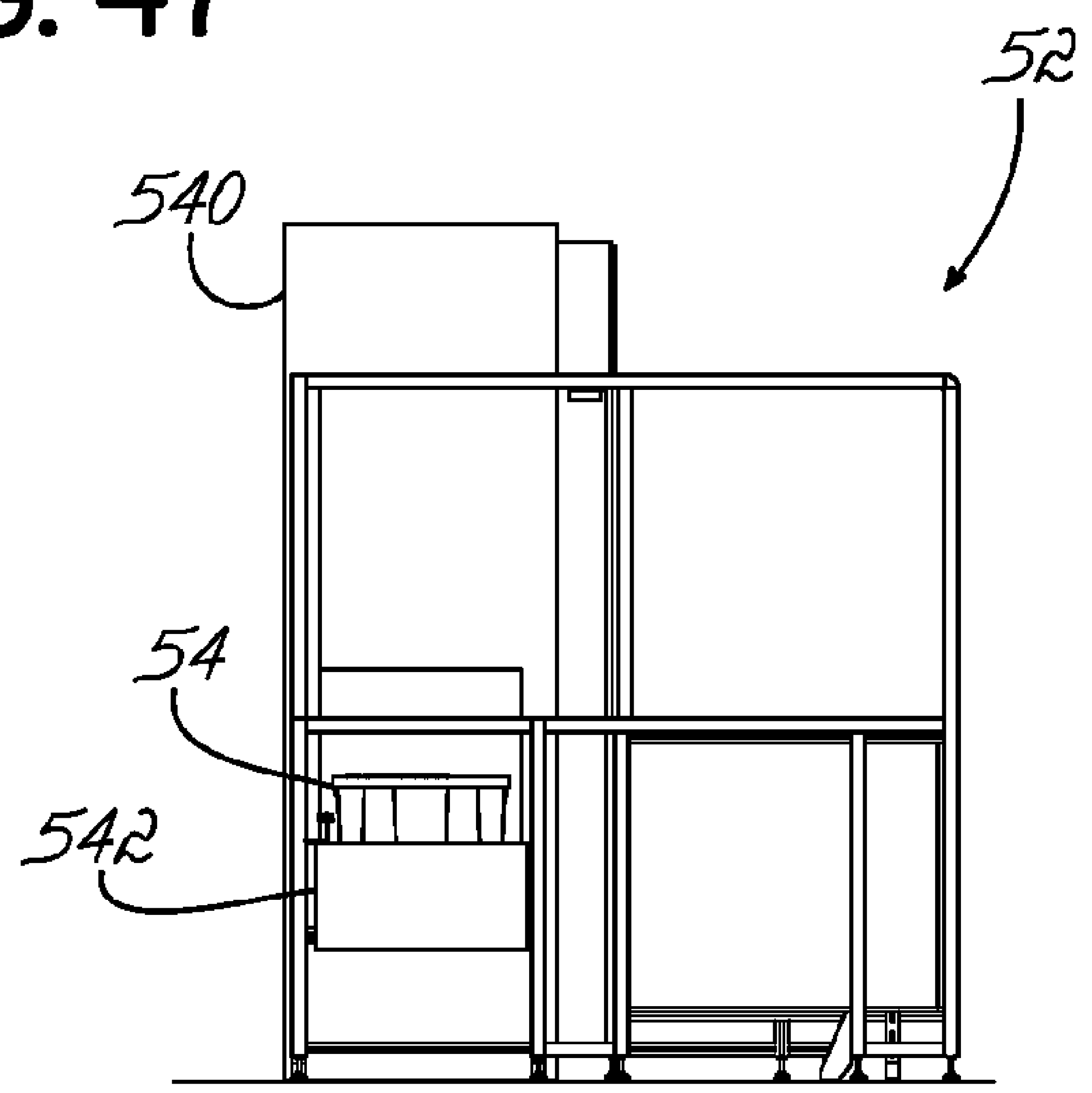

FIG. 48

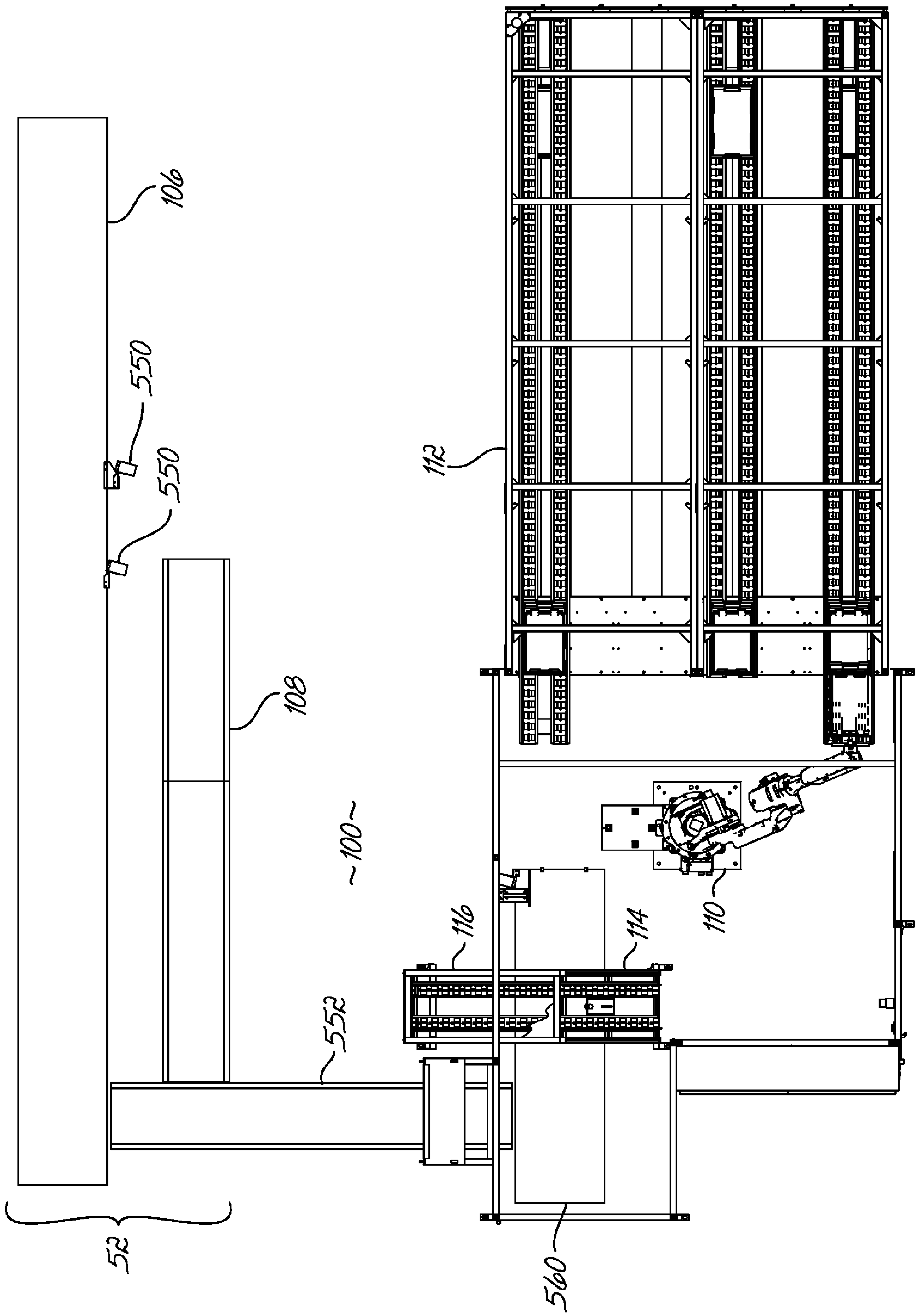

FIG. 49

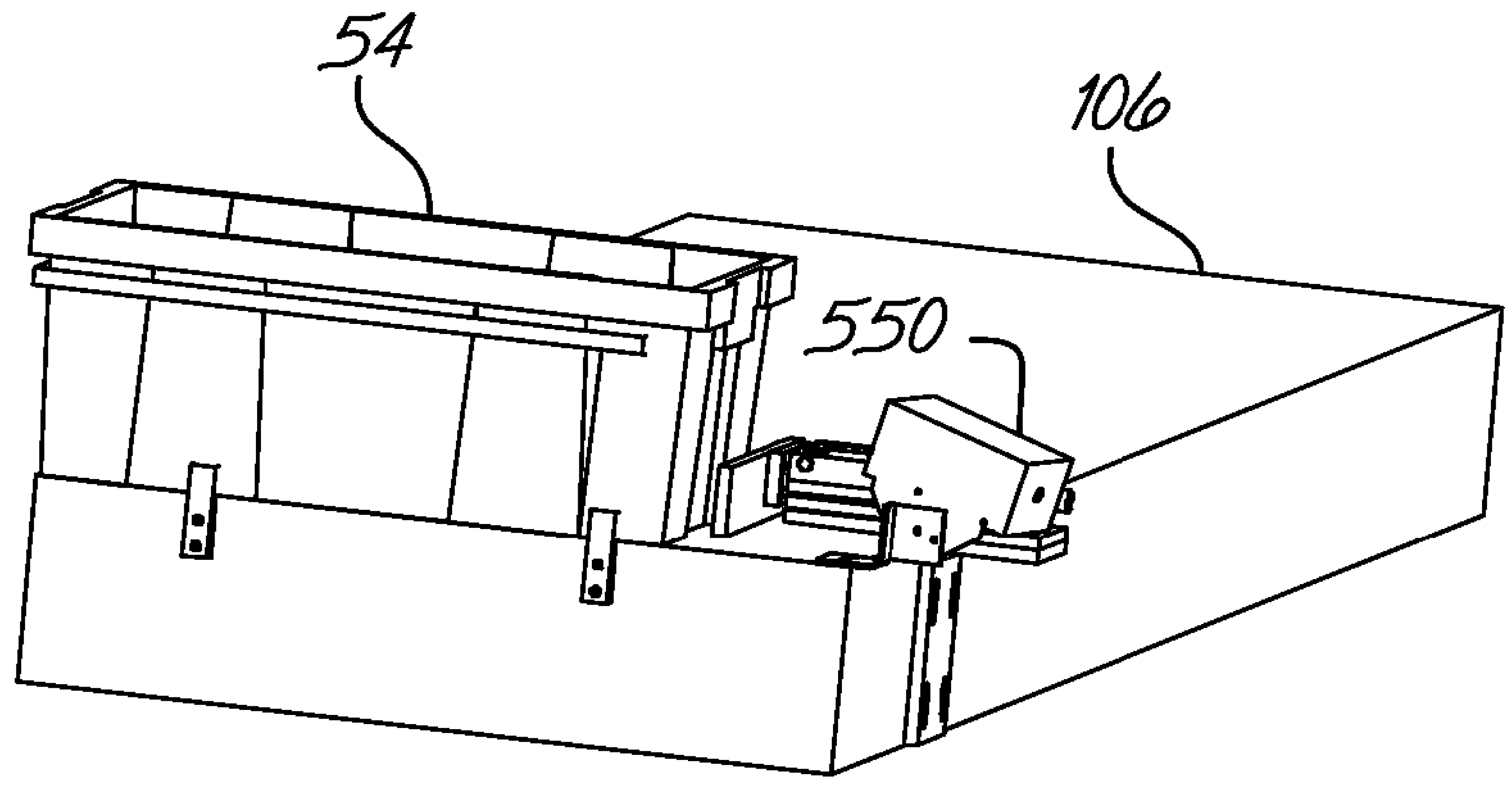

FIG. 49A

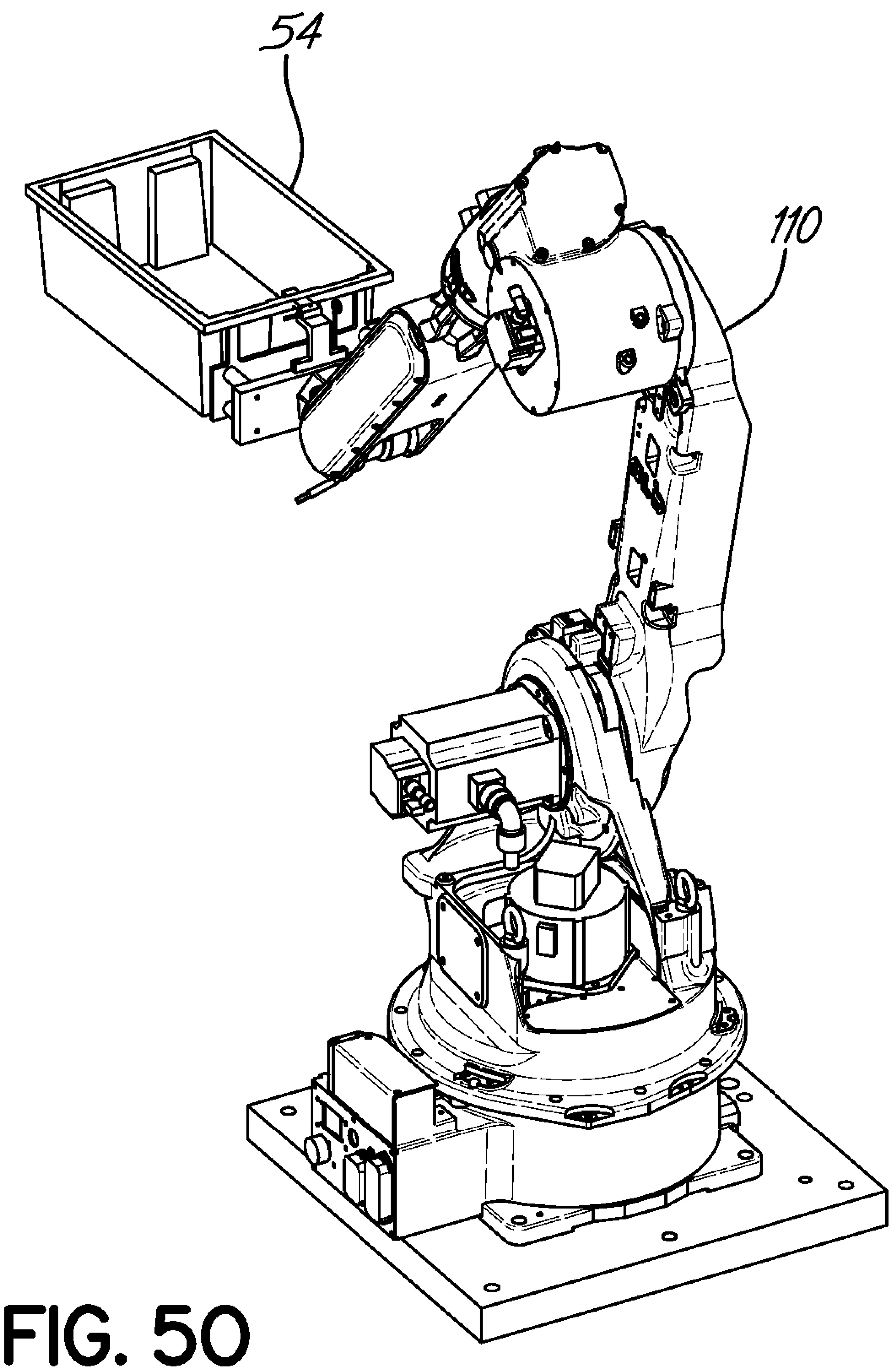

FIG. 50

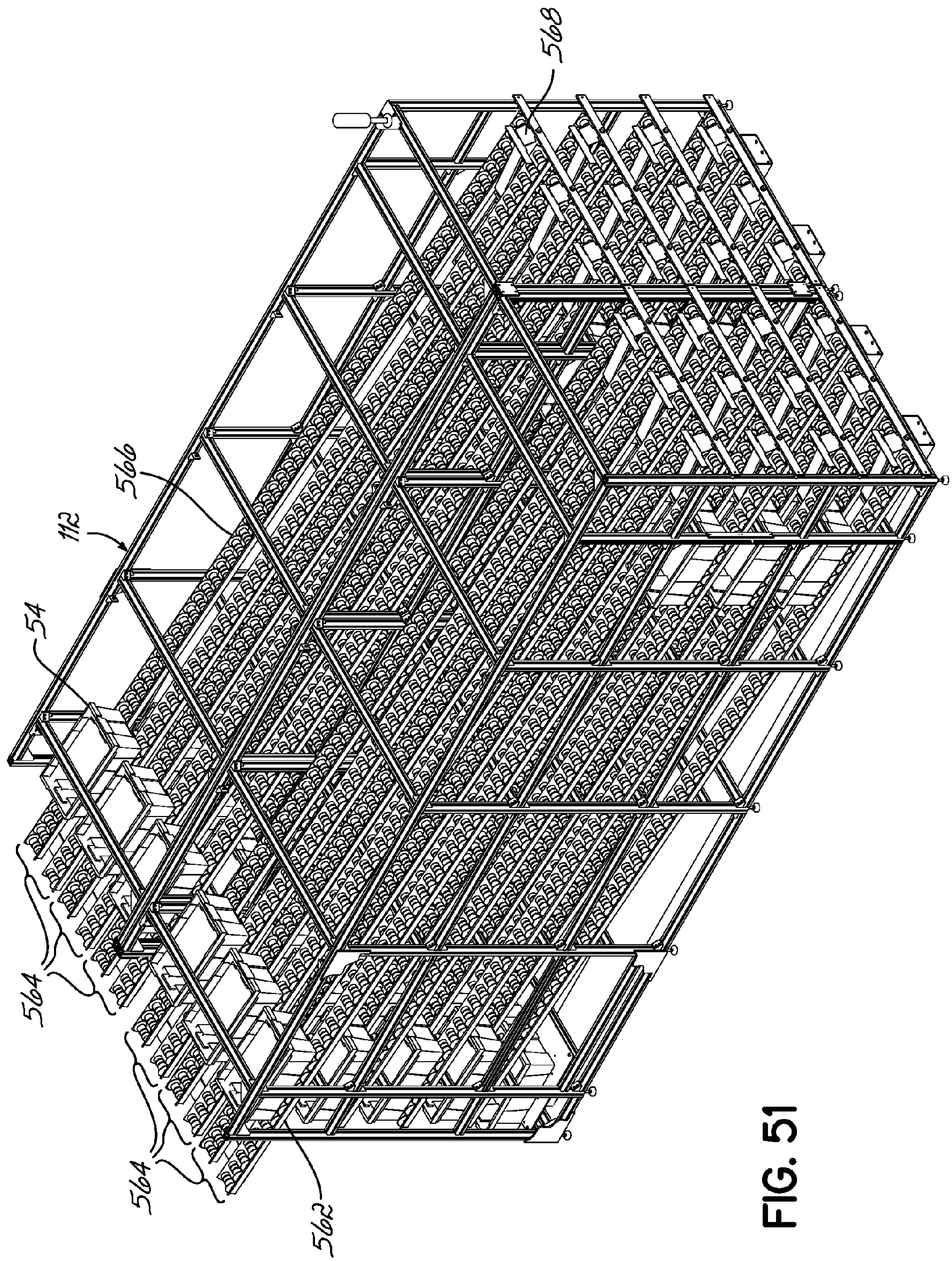

FIG. 51

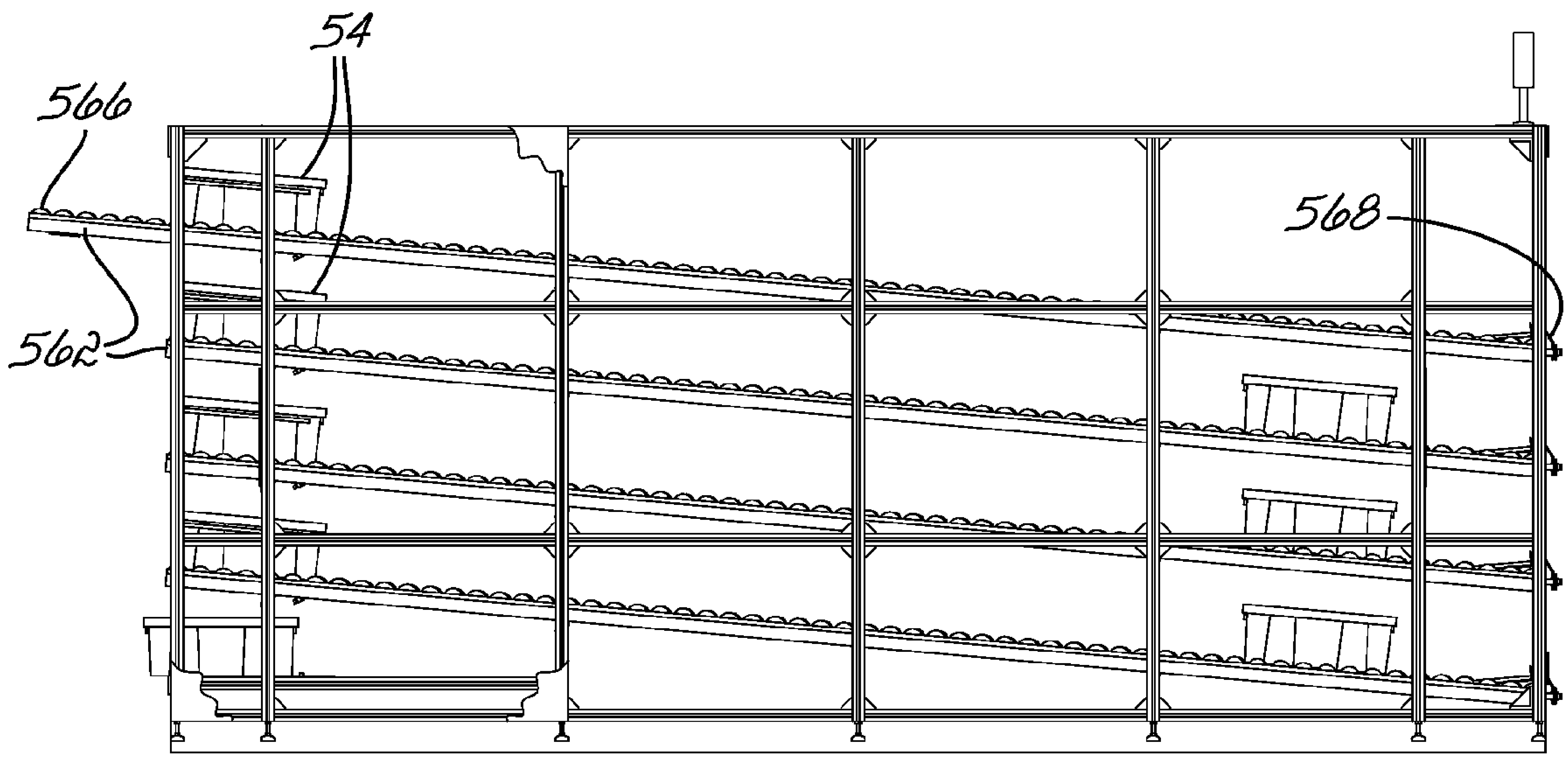

FIG. 52

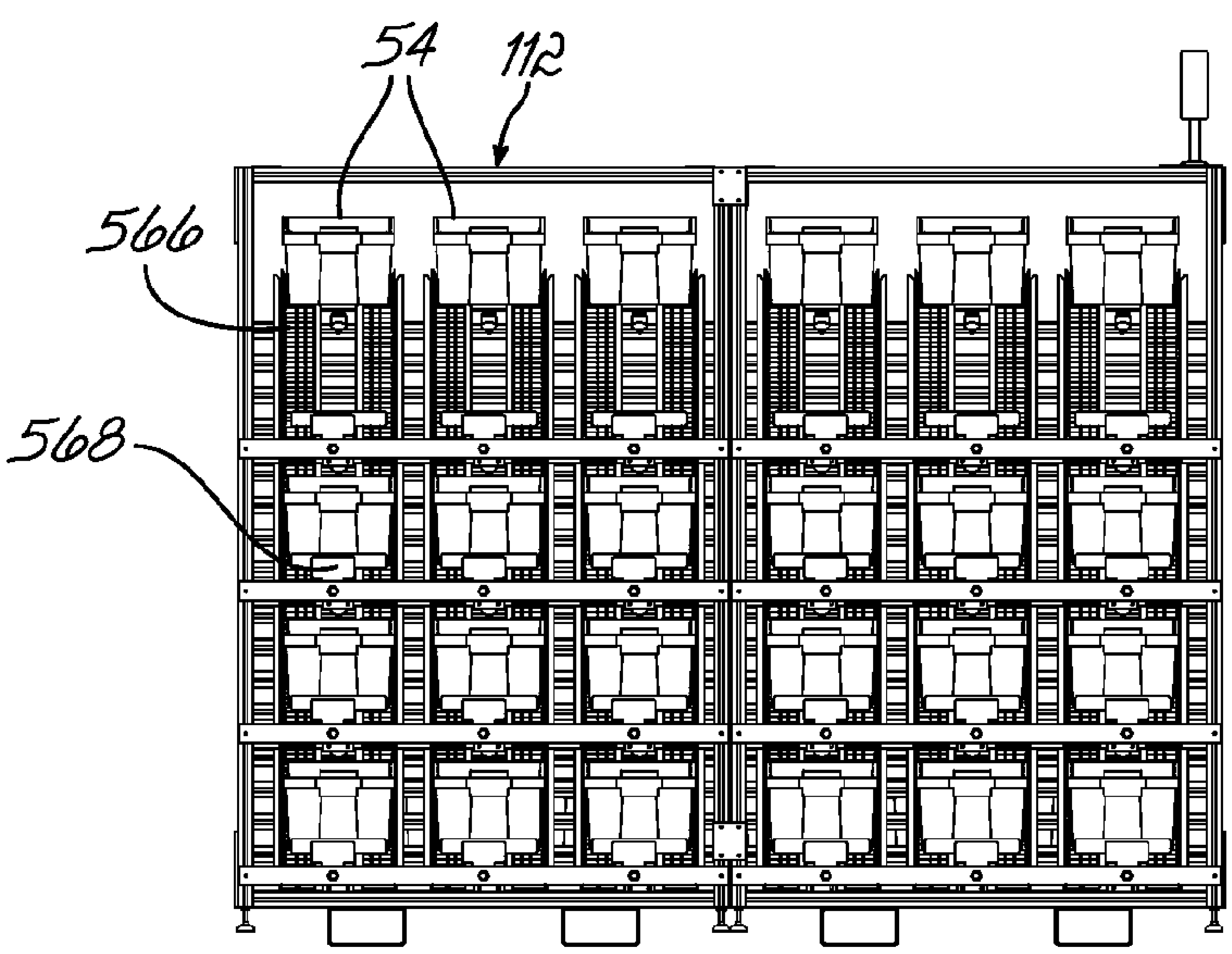

FIG. 53

AUTOMATED LABEL VERIFY SYSTEMS AND METHODS FOR DISPENSING PHARMACEUTICALS

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of U.S. Provisional Patent Application Ser. No. 60/974,181, filed Sep. 21, 2007, and U.S. Provisional Patent Application Ser. No. 61/076,905, filed Jun. 30, 2008, the disclosures of which are hereby incorporated by reference herein in their entireties. The present application is also related to co-pending U.S. application Ser. No. 12/234,985, filed Sep. 22, 2008 and entitled "AUTOMATED LABEL VERIFY SYSTEMS AND METHODS FOR DISPENSING PHARMACEUTICALS," the disclosure of which is hereby incorporated by reference herein in its entirety.

BACKGROUND

This disclosure relates to systems and methods for dispensing pharmaceuticals and, in particular, to automated systems and dispensing methods for filling pharmaceutical orders.

Historically, pharmacies have filled large quantities of customer orders for skilled nursing facilities, assisted living facilities, independent living facilities, group homes, hospice facilities and other configurations of the nursing home industry and institutionalized long term care industry with a labor-intensive, pharmacist-based assembly line method. The customer orders are comprised of patient prescriptions, issued by a physician and fulfilled under close pharmacist supervision. The filling of prescriptions consists of executing the customer order by associating the correct pharmaceutical product with the correct prescription label. This is done by pharmacists, technicians, or combinations of these individuals. Products, in the form of a variety of packages (e.g., 7-day, 14-day, 15-day, 30-day dosages, and individually by form and strength), are removed from bulk inventory and, thereafter, a prescription label is printed and manually applied to the appropriate product.

This act of application may then be verified in one of many ways. It can be checked against a master order sheet (MAR), visually checked by the technician, pharmacist, or a combination of these individuals, or can be verified by manually scanning the information on the prescription label with that of the product label. Once each product is labeled, then the labeled products are grouped and presorted into containers. The presorted containers are broken down in a sortation area where the products are individually scanned and placed into the shipping containers (e.g., boxes, bags, bins, or totes). Typically at this point, the label application is re-verified and the product's association with the particular shipping container is checked. This is a barcode-scanning step where the package label, the prescription label, and the shipping tote (or a combination of any number of these items) are confirmed to be correct.

By the time a labeled and verified product is correctly placed in a shipping tote, it has typically been handled, or touched, by an individual approximately 11-13 times. The large number of touches required to process products represents inefficiencies and increases the potential for human error. Therefore, there remains significant room for improvement in the methodologies used by pharmacies to fill prescriptions against customer orders. What is needed are

improved systems and methods for automatically labeling, verifying, and handling products that constitute the customer orders.

SUMMARY

An apparatus and method for filling a customer order with plurality of products each containing a pharmaceutical are described below. In one embodiment, the apparatus comprises a machine defining a workflow path for products shaped with at least two different form factors. A plurality of stations are configured to automatically label each of the products shaped with the at least two different form factors and to verify that each of the products belongs in the customer order.

In another embodiment, each of the products is marked with a product barcode. The apparatus of this embodiment comprises a conveyor defining a workflow path for processing the products, a label application station in the workflow path of the conveyor and configured to print and apply a patient label onto each of the products, a vision inspection station configured to independently verify that the product barcode on each of the products matches a patient barcode on the patient label (i.e., that the product barcode is associated with the proper patient barcode) after application to the product, and an unloading station configured to transfer labeled and verified products away from the conveyor. The conveyor may be, for example, a dial conveyor defining a circular workflow path about which the label application station and the vision inspection station are arranged.

In a further embodiment, the apparatus also includes at least one product loading station configured to receive batches of the products and to singulate the products in each of the batches. Multiple product loading stations are provided in embodiments of the apparatus that process products shaped with different form factors. In one specific embodiment, a card loading station is configured to receive and singulate batches of the products shaped with a card form factor, and a box loading station is configured to receive and singulate batches of the products shaped with a box form factor.

An apparatus for filling a customer order with a plurality of the products according to another embodiment generally comprises a product loading station, a first verification station, a label printing station, and a second verification station. The product loading station is configured to receive batches of the products and to singulate the products for subsequent movement along a workflow path. The first verification station is configured to receive the products singulated by the product loading station. A barcode reader in the first verification station is configured to read a product barcode on each of the products, and a transfer arm is configured to remove the products from the workflow path. The label printing station is configured to receive the products not removed from the workflow path by the transfer arm and includes a label printer configured to print patient labels and an applicator configured to apply each patent label on one of the products. The second verification station is configured to receive the products from the label printing station. Additionally, the second verification station includes a barcode reader configured to read the product barcode on each of the products and a patient barcode on each of the patient labels and a transfer arm configured to remove the products from the workflow path.

In one specific embodiment of this apparatus, the product loading station, the first verification station, the labeling station, and the second verification station are configured to process products shaped with at least two different form factors. In another specific embodiment, the apparatus further includes a dial conveyor configured to serially transfer the products to the label printing station and the second verification station along the workflow path.

A method of filling a customer order with a plurality of the products, with the products loaded into a machine for processing, is also provided. The method comprises automatically verifying a product barcode on each of the products, printing a patient label for each of the products processed in the machine, applying the patient labels to at least some of the products, and, thereafter, independently verifying that the product barcode matches a patient barcode on the patent label (i.e., that the product barcode is associated with the proper patient label). In one specific embodiment, the independent verification is accomplished by reading the product barcode and the patient barcode on each product with one or more barcode readers, comparing the product barcode read from each product to tracking data to verify that the product belongs in the customer order being filled, and comparing the patient barcode read from each product to tracking data to verify that the correct patient label has been applied to the correct product. In another specific embodiment, the method further comprises singulating batches of the products loaded into the machine so that the products can be individually processed by the machine.

Another method of filling a customer order with a plurality of the products comprises generating pick requests for the products with a pharmacy host server, transmitting the pick requests to an automated dispensing system, and managing the pick requests with the automated dispensing system to generate pick batches for containers to be filled with products. The pick batches represent products to be loaded into the automated dispensing system. To this end, the method further comprises operating the automated dispensing system to automatically process the products and place the products into the containers.

In a further embodiment of this method, managing the pick requests with the automated dispensing system comprises applying sortation rules to the pick requests to generate the pick batches and controlling the operation of the automated dispensing system based upon the pick batches. The operation of the automated dispensing system is controlled by switching the automated dispensing system between a mode of operation wherein the products are placed into shipping totes for delivery to a customer facility, a mode of operation wherein the products are placed into processing totes that represent partial orders for the customer facility, and a mode of operation wherein the products are placed into containers representing a storage area in a pharmacy.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of an embodiment of an ALV (auto-label-verify) system.

FIG. **2** is a top plan view of the ALV system shown in FIG. **1**.

FIG. **3** is a top plan view showing the layout of an ALV machine in the ALV system of FIG. **1**.

FIG. **4** is a perspective view of the ALV machine and a portion of a tote conveyor system of the ALV system.

FIG. **5** is a front elevation view of the ALV machine of FIG. **3**.

FIG. **6** is a perspective view of a product having a blister card form factor.

FIG. **7** is a perspective view of a product having a box form factor.

FIG. **8** is a perspective view of a pick-to-light rack used in the ALV system of FIG. **1**.

FIGS. **9**, **10**, and **11** are respective perspective, side elevation, and top plan views of a product induction magazine for singulating a stack of the blister cards and a camera assembly for reading product barcodes on the blister cards.

FIGS. **12** and **14** are perspective and side elevation views, respectively, of the product induction magazine.

FIG. **13** is a top plan view of the product induction magazine of FIGS. **12** and **14** with the blister cards omitted for clarity.

FIG. **15** is a perspective view of a gripping device of the product induction magazine of FIGS. **9-14**.

FIGS. **16** and **17** are perspective and top plan views, respectively, of a box loading conveyor of the ALV machine.

FIGS. **18** and **19** are perspective and top plan views, respectively, of a box transfer assembly of the ALV machine.

FIGS. **20** and **21** are perspective and top plan views, respectively, of a box infeed conveyor of the ALV machine.

FIG. **22** is a perspective view of a camera assembly associated with the box infeed conveyor of the ALV machine.

FIG. **23** is a perspective view of a box rotation mechanism associated with the box infeed conveyor of the ALV machine.

FIGS. **24** and **25** are perspective and side elevation views, respectively, of a robot used to transfer products from the product induction magazine and box infeed conveyor to the ALV machine.

FIG. **26** is a perspective view of a dial conveyor of the ALV machine.

FIG. **27** is a perspective view of a nesting assembly supported by the dial conveyor of FIG. **26**.

FIG. **28** is a top plan view of the nesting assembly with a blister card positioned on a nesting plate.

FIGS. **29** and **30** are side and front elevation views, respectively, of the nesting assembly with a box positioned on the nesting plate.

FIG. **31** is a perspective view of a lifting assembly configured to raise and lower the nesting assembly of FIG. **27**.

FIGS. **32** and **33** are perspective and side elevation views, respectively, of one embodiment of a label printer used with the ALV machine.

FIG. **34** is a perspective view of the components of a labeling station of the ALV machine.

FIGS. **35** and **36** are perspective and side elevation views, respectively, of a label applicator used in the labeling station of FIG. **34**.

FIGS. **37** and **38** are perspective and top plan views, respectively, of a flattening device used in the labeling station of FIG. **34**.

FIGS. **39** and **40** are perspective and top plan views, respectively, of a label rejection device used in the labeling station of FIG. **34**.

FIGS. **41** and **42** are perspective and side elevation views of a label wiping device associated with the ALV machine.

FIG. **43** is a perspective view of a vision inspection station of the ALV machine.

FIG. **44** is a perspective view of a robot representing an unloading station of the ALV machine.

FIG. **45** is a schematic view illustrating how products may be deposited into a container in an organized manner.

FIG. **46** is a rear elevation view of a tote conveyor system of the ALV system.

FIG. **47** is a top plan view of the tote conveyor system of FIG. **46**.

FIG. **48** is a side elevation view of the tote conveyor system of FIG. **46**.

FIG. **49** is a top plan view of a tote handling system of the ALV system.

FIG. **49**A is a perspective view schematically illustrating a barcode reader of the tote conveyor system of FIG. **46**.

FIG. **50** is a perspective view of a tote load robot of the tote handling system of FIG. **49**.

FIG. **51** is a perspective view of a tote rack of the tote handling system of FIG. **49**.

FIG. **52** is a side elevation view of the tote rack of FIG. **51**.

FIG. **53** is a front elevation view of the tote rack of FIG. **51**.

DETAILED DESCRIPTION

FIGS. **1** and **2** show one embodiment of an Auto Label Verify (ALV) system **10**. The ALV system **10** is an automated pharmacy order dispensing system that enables pharmacy orders to be processed in an efficient manner using new methodologies. To facilitate discussion of the ALV system **10** and these methodologies, a general overview of the ALV system **10** is provided below, followed by a discussion of the methodologies for fulfilling pharmacy orders, before describing components of the ALV system **10** in considerable detail.

I. Overview of the ALV System

By way of background, the ALV system **10** may be used to dispense and fulfill prescriptions in products **12** of at least two different form factors. The products **12** are shown in the form of blister cards **20** (FIG. **6**) that hold a number of pills (i.e., dosages of pharmaceuticals in oral solid form) and boxes **22** (FIG. **7**) that may be prepackaged with individual thermoformed blister strips (not shown) or other packaged of pharmaceuticals. However, those skilled in the art will appreciate that aspects of the invention described below—especially the methodologies discussed in connection with the operation of the ALV system **10**—are not necessarily limited to such form factors. Thus, reference number **12** will be used to generically refer to both blister cards **20** and boxes **22**, along with other potential form factors, where appropriate to facilitate discussion.

A product barcode **24** on each product **12** reflects the contents of the product **12**. Groups of products **12** in a common bulk shipper case supplied to the pharmacy typically share the same mutual product barcode **24**. The product barcode **24** may be printed directly on a surface of the product **12** or, alternatively, may be printed on a label that is affixed to a surface of the product **12**. The product barcode **24** is positioned on the different products **12** of the same form factor in a consistent manner (i.e., at substantially the same location on the products **12**) so that it can be brought into the field of view of readers used by the ALV system **10** to read the product barcode **24**. To that end, as shown in FIG. **6**, the product barcode **24** on each of the blister cards **20** may be positioned on a front surface **26** near one corner of the blister card **20** and inset slightly from the card perimeter. As shown in FIG. **7**, the product barcode **24** on each of the boxes **22** may be positioned on one of two sidewalls **28**, **30** of the box **22**. Regardless of the form factor, the positioning of the product barcode **24** on the products **12** is chosen such that the product barcode **24** is not obscured or obstructed after a patient label **32** is applied to the product **12** by components within the ALV system **10**.

The patient label **32** (outlined schematically in FIGS. **6** and **7**) is printed on conventional label stock and includes an adhesive backing for adhesively bonding to the product **12**. A patient barcode **34**, which encodes information relating the prescription, is situated within a given spatial window or footprint inside the perimeter of the patient label **32**. The ALV system **10** is tolerant of slight inaccuracies in the precise location of the patient barcode **34** on the patient label **32** and of the patient label **32** on the product **12** for purposes of reading the patient barcode **34**. The positioning of the patient barcode **34** on the labeled products **12** is reproducible to an extent necessary for the field of view of readers used by the ALV system **10** to read the patient barcode **34**. The patient label **32** may further include human-readable information relating to the drug or pharmaceutical contained in the product **12** and/or the customer for the pharmaceutical contained in the product **12**.

With this general understanding of the products **12** processed by the ALV system **10**, an overview of the ALV system **10** will now be explained with reference to FIGS. **1-5**. The ALV system **10** includes a pick-to-light system **40** having pick-to-light racks **42** that hold bulk shipper cases **44** containing the products **12**, an ALV machine **50** that processes the products **12**, a tote conveyor system **52** that supplies containers **54** for receiving the products **12** processed by the ALV machine **50**, and a tote handling system **56** that handles filled containers **54** from the tote conveyor system **52**. One aspect of the ALV machine **50** is its ability to interchangeably handle products **12** of different form factors without any reconfiguration or alteration to the ALV machine **50**.

An ALV Order Manager (AOM) control system interfaces with a pharmacy host server to manage information sent to and from the ALV machine **50** and pick-to-light system **40**. The ALV machine **50** processes products **12** pulled by an operator from the racks **42** of the pick-to-light system **40** by passing them through various stations designed to serve one or more specific functions. To this end, the ALV machine **50** includes both a card loading station **60** and a box loading station **62** for receiving the products **12** pulled by an operator from the racks **42** of the pick-to-light system **40**. The card loading station **60** and box loading station **62** are each configured to read the product barcode **24** (FIGS. **6** and **7**) on the associated type of products **12** (i.e., blister cards **20** and boxes **22**) to verify and track the products **12**. This verification task is achieved while delivering the products **12** in an organized manner to a transfer station **64**, which includes a transfer arm in the form of a robot **66** for transferring the products **12** to designated locations on a rotary or dial conveyor **68**. The robot **66** also transfers the products **12** to a first reject bin **70** (instead of the dial conveyor **68**) under certain conditions, such as when a product **12** cannot be verified. Thus, aspects of the card loading station **60** and box loading station **62**, together with the transfer station **64**, serve as a first product verification and rejection (PVR1) station.

The dial conveyor **68** rotates to deliver or bring the products **12** to a labeling station **76**. At this station, the ALV machine **50** prints the patient labels **32** (FIGS. **6** and **7**) having patient-specific information in the form of the patient barcode **34**, verifies that the patient barcode **34** is printed on each patient label **32**, and applies each successfully-verified patient label **32** to the corresponding product **12**. More specifically, a label printer **78** associated with the ALV machine **50** prints the patient labels **32** to apply the patient-specific information. A label applicator **80** verifies the patient barcode **34** and applies the associated patient label **32** to the corresponding product **12**. Patient labels **32** that fail verification are applied to label reject device **82** rather than to one of the products **12**. Thus, the labeling station **76** serves as a label print, verify, and apply (LPVA) station.

When products **12** in the form of boxes **22** are being processed, the labeling station **76** applies the associated patient label **32** to a front surface **88** (FIG. **7**, viewed from above and looking downwardly) of each box **22**. The patient label **32** has a width greater than that of the front surface **88** such that projecting portions of the patient label **32** extend outwardly above the sidewalls **28**, **30** when the patient label **32** is applied to the front surface **88**. To complete the label application process, the dial conveyor **68** further rotates to bring the box **22** to a label wipe station **90** that pushes these projecting portions flat onto the opposed sidewalls **28**, **30** of the box **22**. The blister cards **20** are not processed by the label wipe station **90** because the patient labels **32** are initially applied entirely flat onto the front surface **26** (FIG. **6**) of this form factor.

The next station associated with the circular workflow path of the dial conveyor **68** is a vision inspection station **92** that performs another verification step. At this station **92**, the ALV machine **50** re-verifies both the product barcode **24** on the product **12** and the patient barcode **34** on the patient label **32**. If either of the barcodes **24**, **34** cannot be read or do not match/correlate with product tracking data, the product **12** is flagged as a reject. If the barcodes **24**, **34** do match/correlate with product tracking data, the product **12** is flagged as an accepted item.

Finally, the dial conveyor **68** brings the product **12** to an unloading station **94**. A robot **96** at the unloading station **94** transfers the products **12** flagged as rejects into a second reject bin **98** and transfers the products **12** flagged as accepted items into one of the containers **54** on the tote conveyor system **52**. Thus, the vision inspection station **92** and unloading station **94** serve as a second product verification and rejection (PVR2) station.

The tote conveyor system **52**, which is tightly integrated with the operation of the ALV machine **50**, sends the containers **54** filled with verified and labeled products **12** along a main conveyor **106** to the tote handling system **56**. The tote conveyor system **52** also includes a parallel conveyor **108** so that the filled containers **54** can alternatively be sent to an audit station **100** whenever an audit is desired for quality assurance. At the audit station **100**, an operator uses a hand-held barcode scanner and operator's interface (neither of which are shown) to verify the contents of the container **54** before passing the container **54** to the tote handling system **56**. A tote load robot **110** in the tote handling system **56** places the containers **54** onto a tote rack **112** or, when an audit is to be performed, onto a tote return conveyor **114** leading to an escapement **116** where an operator at the audit station **100** can pick up the container **54**. Thus, a filled container **54** may be transferred to the audit station **100** by either the tote conveyor system **52** or the tote handling system **56**.

Although only one ALV system **10** is shown, a pharmacy can house multiple ALV systems (not shown) each identical or substantially similar to ALV system **10**. The ALV system **10** may constitute stand-alone stations in a non-integrated pharmacy, each having their own tote conveyors systems **52** and tote handling systems **56**, or components of an integrated (i.e., automated) pharmacy in which the individual ALV systems **10** are linked together by a shared tote conveyor system and/or tote handling system. In the latter instance, multiple ALV systems **10** inside the same pharmacy may be logically connected to one of the ALV systems **10** (designated as the primary ALV system **10**) via a communications channel, such as an Ethernet communications channel, and physically connected to the tote conveyor system and/or tote handling system shared by the multiple ALV systems **10**. The AOM control system of the primary ALV system **10** may be used to control one or more of the additional ALV systems **10** housed in the pharmacy.

II. Using the ALV System to Fulfill Pharmacy Orders

The ALV system **10** represents an automated order dispensing system situated within the pharmacy that is used fulfill prescriptions specified by customer orders. A customer order represents prescriptions delivered to a customer location (e.g., nursing facility) in a particular shipment from the pharmacy. As such, the customer order may thus comprise a collection of individual patient orders for the patients at the customer location. Each patient order may include one or more prescriptions, and each individual prescription may include one or more products **12** of the blister card **20** or box **22** form factor. The products **12** of each prescription have a unique drug stock keeping unit (SKU) representing medication type, strength, form factor for the product packaging, etc. Drug SKUs are assigned and serialized for inventory management at the source of the products **12**. The products **12** may also include printed or labeled human-readable information, such as the manufacturer or supplier name, medication type, medication strength and description, lot number, expiration date, etc.

A pharmacy host server (i.e., computer system) communicates with, and gives tasks to, the ALV system **10**. The pharmacy host may be, for example, a warehouse management system or a warehouse control system. This pharmacy host tracks inventory in the pharmacy and tracks and directs orders through the pharmacy. Orders from the pharmacy host are sent to the ALV system **10** in the form of "pick requests" for the products **12**.

The AOM control system applies various sort rules/logic to manage the pick requests received from the pharmacy host server. For example, the AOM control system may group incoming picks by customer facility, order the picks by priority, group by drug, group by patient, etc. The number of orders processed by the pharmacy host server, and, thus, the number of pick requests sent to the AOM control system, typically varies depending on the time of day. There may be high volumes of orders received at certain peak times (e.g., at the beginning and end of normal working hours) and low volumes at other times (e.g., the late evening hours). Advantageously, the AOM control system manages pick requests received from the pharmacy host server so that customer orders are processed in an opportunistic manner.

More specifically, the ALV system **10** operates in three different modes of operation to optimize efficiency. During high-volume times of the day, the ALV system **10** operates in an on-demand mode. The containers **54** processed by the ALV system **10** in this mode of operation are shipping totes that will be delivered to a customer facility. The large number of pick requests at these times enables the AOM control system to sort the pick requests into large pick batches for each facility. The products **12** corresponding to the pick batches fill, or substantially fill, the shipping totes. As briefly described above, the ALV system **10** automatically prints and applies patient labels **32**, verifies the product and patient barcodes **24**, **34**, and deposits the labeled and verified products **12** into the containers **54**. The containers **54** are verified as well (by barcode readers associated with the tote conveyor system **52**, as will be discussed below). Because the containers **54** are shipping totes that will be delivered to the customer facility, no further processing or verification steps are required during this mode of operation.

During other times of the day when there are moderate volumes of customer orders, the on-demand mode begins to lose some of its efficiency. The pick batches produced by the on-demand sort rules of the AOM control system are smaller and do not fill the shipping totes. As a result, the ALV system **10** switches to a mode of operation in which the containers **54** are work-in-process (WIP) totes that are less cumbersome to work with and that remain inside the pharmacy. This WIP tote mode of operation involves automatically filling the WIP totes with the labeled and verified products **12** corresponding to the smaller pick batches. Thus, the WIP totes are loaded with the products **12** in a manner similar to the shipping totes.

The WIP totes may even be transferred to the tote racks **112** of the tote handling system **56** after receiving the products **12**. The difference, however, is that an additional processing step takes place during this mode of operation.

Specifically, the products **12** in two or more WIP totes associated with a customer order must later be combined/transferred into a common shipping tote. Each WIP tote includes a barcode so that the products **12** placed therein can be verified for proper association with the WIP tote (similar to the verification of the shipping totes). Because of this WIP tote verification, the products **12** can be transferred to the shipping totes and verified for proper association with the shipping totes without having to individually scan each product **12**. Instead, an operator simply scans the WIP tote and the shipping tote before transferring all of the products **12** from the WIP tote into the shipping tote. This scanning step is performed for each WIP tote whose contents are transferred to a particular shipping tote.

During times of the day when there are the lowest volumes of customer orders, the pick batches generated by the AOM control system using the on-demand sort rules become even smaller. This results in operators walking more between the pick-to-light racks **42** and the ALV machine **50**. Additionally, the number of WIP totes whose products **12** must be combined to fill a single shipping tote increases, resulting in more scanning steps. Because of these inefficiencies, the ALV system **10** switches to an "aisle tote" mode of operation. In this mode of operation, the AOM control system groups incoming picks by SKU and sorts them by aisle or section of the pharmacy where they are to be temporarily stored. This allows for larger pick batches to be generated. The aisle totes are filled with labeled and verified products **12** and then taken to their temporary storage locations. Operators then fill shipping totes in a conventional manner by selecting individual products **12** from the various storage locations and scanning each product **12** for verification as it placed in the shipping tote.

As can be appreciated, the ALV system **10** significantly automates the process of fulfilling pharmacy orders. The automation enables a large number of pick requests to be processed quickly and reliably with little human intervention, representing significant cost savings. Indeed, in on-demand mode, the products **12** are labeled, verified, and ready to ship to a customer facility after being "touched," or handled, only once by an operator (the touch occurs during transfer from the pick-to-light system **40** to the ALV machine **50**). In WIP tote mode, the products **12** are "touched" twice because of the additional handling step when transferring the products **12** from the WIP totes to the shipping totes. However, WIP tote mode still avoids the need to individually scan each labeled and verified product **12** during transfer to the shipping totes. Although operators must still manually perform such steps in aisle tote mode, the ALV system **10** still provides several advantages. In all modes of operation, the steps of manually applying the patient label **32** to the product and verifying the patient barcode **34** and product barcode **24** immediately after label application is automated by the ALV system **10**. Thus, the ALV system **10** still provides significant cost-saving opportunities even when operating in aisle tote mode.

Having described the methodologies used by the ALV system **10** to fulfill pharmacy orders, the various components of the ALV system **10** will now be described in the further detail.

III. Components of the ALV System

(a) Controls

The ALV machine **50** of the ALV system **10** is controlled by a controller (not shown), such as a programmable logic controller (PLC) or, in a specific embodiment, an Allen-Bradley CompactLogix PLC. The controller may include one or more central processing units (CPUs) for processing programmable components contained in a memory card or extendable memory, a power supply unit, an input/output control module, and other components recognized by a person having ordinary skill in the art. The controller is programmed with a series of program components having a series of algorithms for controlling the mechanical functions of the ALV machine **50**, as well as operating as an input/output interface to the various barcode readers, motors, and movable components contained in the ALV machine **50** and an input/output interface to a human machine interface (HMI) computer **130** (FIG. **5**). These program components may be stored in memory and executed by one of the CPUs within the controller.

The controller is used to coordinate and orchestrate the mechanical functions of the ALV machine **50**. The communications interface(s) may comprise any common communications channel technology recognized by a person having ordinary skill in the art, including but not limited to Ethernet, Fieldbus (CAN/CAN OPEN), or Serial (RS-232) protocols. The controller tracks product data associated with each of the products **12** processed by the various stations of the ALV machine **50**. Product information and status from the tracking data can be displayed and updated on demand at the HMI computer **130**.

With reference to FIG. **5**, the HMI computer **130** is supported by framework **132** of the ALV machine **50** at an elevated location near the card loading station **60** and box loading station **62**. The HMI computer **130** may run any conventional operating system and may execute different software applications that cooperate with the operation of the controller for controlling the processing of products **12** in the ALV machine **50**. The HMI computer **130**, which permits the operator to interact with the ALV machine **50**, may comprise a touch sensitive display or computer screen that promotes operator interactions. The HMI computer **130** may implement a Graphical User Interface (GUI) on the computer screen that features frames and panes with buttons and specific interface components for operator interaction in connection with test, set up, and run procedures of the ALV system **10**.

The HMI computer **130** communicates over a communications channel, such as Ethernet, with the pharmacy host. As mentioned above, the pharmacy host is a computer system that communicates with, and gives tasks to, the ALV system **10**.

The AOM control system of the ALV system **10** includes multiple processors that implement software applications and collectively process orders and pick requests received from the pharmacy host. The computers, which are coupled together by a communications channel such as Ethernet, include a pick server, a real time pick-to-light computer (PickPC), a statistics computer (StatPC), and an order reconciliation computer. The PickServer, PickPC, and StatPC may be rack-mounted servers physically mounted in the ALV machine **50** or housed in the pharmacy, as appropriate. The PickServer, PickPC, and StatPC may be constructed with fault tolerant redundant power supplies and hot swappable Redundant Array of Independent Disks (RAID) drives. The order reconciliation computer may comprise a desktop personal computer and an interfaced hand-held barcode scanner that can be mounted anywhere in the pharmacy.

(b) Pick-to-Light System

Orders in the form of pick requests are communicated from the pharmacy host to the ALV system **10**. As discussed above, the pick requests are stored by the AOM control system for logical grouping based on user-defined parameters and retrieval. The logical grouping process results in pick batches for the operator to pick from the pick-to-light racks **12**. Each pick batch can contain one or more products **12** destined for a placement into one of the containers **54**.

A representative pick-to-light rack of the pick-to-light system **40** is shown in FIG. **8**. Each of the pick-to-light racks **12** includes a bay controller (not shown) and multiple shelves **140** arranged in levels. Each of the shelves **140** is partitioned by dividers **142** to define multiple bins or inventory locations that are within arms-reach of a technician and stocked with one or more bulk shipper cases **44** (FIG. **1**). Each bulk shipper case **44** holds products **12** characterized by a unique drug SKU. More than one inventory location, typically adjacent inventory locations, in the pick-to-light racks **12** can hold bulk shipper cases **44** holding products **12** with the same drug SKU, which are managed as a single unit by the ALV system **10**. Most drug SKUs have a single inventory location on the shelves **140** of the pick-to-light racks **12**, although products **12** with faster moving drug SKUs can be assigned to multiple inventory locations.

As shown in FIGS. **1** and **2**, the pick-to-light racks **12** can be arranged to surround one or more operators. Some or all of the individual racks **42** of the pick-to-light system **40** may be supported on castors (not shown) that ease re-configuration of the arrangement relative to the ALV machine **50**. The peripheral pick-to-light racks **42** may be arranged in, for example, a U-shape to minimize the walking distance along the aisles from the inventory locations of the pick-to-light system **40** to the ALV machine **50**. However, the pick-to-light racks **12** may have another configuration chosen to accommodate spatial constraints in the pharmacy or a design choice. The vertical position and inclination angle of the shelves **140** in the pick-to-light racks **12** may be adjustable. The pick-to-light racks **12** may be arranged to locate specific inventory locations for products **12** of faster moving drug SKUs closer to the card loading station **60** and box loading station **62** of the ALV machine **50**.

In a manner not shown herein, each inventory location in the pick-to-light racks **12** has a dedicated pick-to-light module with a pick face that includes an indication light, one or more buttons, and an alphanumeric display module. The alphanumeric display indicates to the operator the number of products **12** to be picked for an order, and the buttons permit the operator to adjust the quantity up, or down, if there are inventory issues. The adjustments provide a means for the operator to update the database of the AOM control system with real-time, accurate inventory counts of products **12**. Each of the pick-to-light racks **12** may include other types of pick-to-light modules, such as an order control module, that are operated under the control of the bay controller.

In the workflow sequence for the ALV system **10**, an operator is instructed to pick individual products **12** from the pick-to-light system **40** with visual queues supplied by the indication lights associated with the inventory locations. The indication lights on the pick-to-light modules assist the operator to quickly and accurately identify the inventory locations in the pick-to-light racks **12** for each pick batch. The operator picks products **12** from the lighted inventory locations, adjusts for any inventory (if needed) using the buttons on the pick face, and presses a pick complete button on the pick face of the inventory locations. The operator repeats this process until all lighted inventory locations in the pick-to-light racks **12** are acknowledged, which indicates to the controller that the operator has completed the pick batch.

If the products **12** collected by the operator are in the form of blister cards **20**, the operator delivers the blister cards **20** to the card loading station **60** of the ALV machine **50**. If the products **12** are boxes **22**, the operator delivers the boxes **22** to the box loading station **62** of the ALV machine **50**.

(c) Card Loading Station

FIGS. **9-15** illustrate the components of the card loading station **60** in further detail. The card loading station **60** includes a product induction magazine **150** for feeding blister cards **20** picked by the operator to the loading station of the ALV machine **50** and a camera assembly **152** for verifying the product barcode **24** (FIG. **6**) on the blister cards **20**. In FIGS. **9-11**, the product induction magazine **150** is loaded with numerous blister cards **20**. In FIGS. **12-14**, the product induction magazine **150** is in a substantially empty condition and the camera assembly **152** hidden for clarity.

The product induction magazine **150** includes a feed chute defined by a set of columnar guide posts **154** and a pair of movable arms **156**, **158** that are arranged to extend and retract through respective gaps between an adjacent pair of guide posts **154** into the space inside the chute. The guide posts **154**, which are formed from right angle bar stock, have concave L-shaped vertical channels arranged relative to each other to correlate with the shape of blister cards **20** so that the outside corners of the blister cards **20** project into the concave vertical channel of the nearest guide post **154**. At the top entrance of the chute, the channel of each of the guide posts **154** is flared outwardly to increase the cross-sectional area available to receive the blister cards **20**, which eases introduction of blister cards **20** dropped by the operator into the chute.

Each of the arms **156**, **158** is coupled mechanically with a respective linear motion mechanism in the form of a linear actuator **162**, **164**, for movement relative to the chute between extended and retracted positions. When the arms **156**, **158** are placed in the extended position, a portion of each of the arms **156**, **158** contacts and supports opposite sides of the bottom blister card **20** in a stack of blister cards **20** manually dropped by the operator into the chute of the product induction magazine **150**. The channels of the guide posts **154** collectively guide the vertical movement of the blister cards **20** from the top of the feed chute downward so that the bottom blister card **20** in the stack rests on the arms **156**, **158**. When the controller instructs both linear actuators **162**, **164** to withdraw the arms **156**, **158** outwardly to the retracted position, the group of blister cards **20** is no longer supported and falls under the influence of gravity. The guide posts **154** collectively guide this downward movement until the bottom blister card **20** in the stack rests on a landing plate **166** located beneath the arms **156**, **158**. The stack of blister cards **20** resting on the landing plate **166** is then singulated by the product induction magazine **150**, as described below.

When positioned on the landing plate **166**, a portion of the bottom blister card **20** overhangs a portion of a nesting plate **170** located adjacent to, and in a plane slightly below, the landing plate **166**. A riser **172** may be provided on the landing plate **166** to further elevate the overhanging portion of the blister card **20** relative to the nesting plate **170**. The nesting plate **170** includes a pair of parallel slots **174**, **176** and guide rails **178**, **180** running along its length. To move the bottom blister card **20** away from the stack in the chute and along the nesting plate **170**, the product induction magazine **150** further includes a gripping device **182** having a set of suction members **184***a-d* carried on respective vertical spacer posts **186***a-d*, a linear motion mechanism **188** for laterally shifting a base plate **190** that supports the vertical spacer posts **186***a-d*, and a vertical motion mechanism **192** for vertically shifting the base plate **190**. The gripping device **182** is positioned so that the suction members **184***a-d* are configured to extend through the slots **174**, **176** in the nesting plate **170**. Initially the linear motion mechanism **188**, which is in the form of a linear actuator in the representative embodiment, positions the base plate **190** under the portion of the nesting plate **170** proximate the landing plate **166**. The vertical motion mechanism **192**, which is also in the form of a linear actuator in the representative embodiment, raises the base plate **190** until the suction members **184***a-d* are immediately adjacent to and/or in contact with the overhanging portion of the blister card **20** on the landing plate **166**.

Suction is supplied to the suction members **184***a-d* from a vacuum source (not shown) so that the suction members **184***a-d* aspirate the air from any space between the suction members **184***a-d* and the blister card **20** on the landing plate **166** to apply an attractive force that engages the overhanging portion of the blister card **20** with the suction members **184***a-d*. With the blister card **20** so grasped, the vertical motion mechanism **192** moves the base plate **190** and suction members **184***a-d* downward by a distance sufficient for the leading end of the blister card **20** to clear a bottom edge **194** of a blocking plate **196**. The linear motion mechanism **188** then shifts the base plate **190** horizontally by a distance sufficient to move the blister card **20** past the blocking plate **196** and out of the chute. The guide rails **178**, **180** provided on the nesting plate **170** help guide this horizontal movement.

The blister card **20** is brought to a "dead area" location on the nesting plate **170** accessible by the robot **66** (FIG. **3**) of the transfer station **64**. At this point, the suction members **184***a-d* are vented to release the attractive force applied to the singulated blister card **20**. The linear motion mechanism **188** and vertical motion mechanism **192** then return to their initial positions, ready to singulate the next blister card **20** in the stack. The solenoid valves for the linear motion mechanism **188**, vertical motion mechanism **192**, and vacuum source for the suction members **184***a-d* are electrically coupled with, and controlled by, the controller. Sensors (not shown) are provided that detect the presence of one or more blister cards **20** captured by the arms **156**, **158** and one of the blister cards **20** residing on the landing plate **166**. These sensors supply feedback to the controller for operating the solenoid valves for the linear motion mechanism **188**, vertical motion mechanism **192**, and vacuum source for the suction members **184***a-d*. A sensor **200** is also mounted to the nesting plate **170** to detect when a blister card **20** has been delivered to the dead area.

Before being transferred to the dial conveyor **68**, the product barcode **24** on each of the singulated blister cards **20** is verified by the camera assembly **152**. The camera assembly **152** includes a pair of vertical shafts **210**, **212** that support a camera mount **214** and camera cover **216** above the nesting plate **170**. A camera **215** held by the camera cover **216** is configured to take one or more images of the product barcode **24** on the blister card **20** singulated onto the nesting plate **170**. The controller activates the camera **215** when the sensor **200** detects the presence of the blister card **20**. To aid in capturing the images, a lighting assembly **218** is mounted to the nesting plate **170** and configured to emit light toward the product barcode **24**. The controller analyzes the images captured by the camera **215** using machine vision software. In alternative embodiments, the card loading station **60** may include a laser scanner (not shown) configured to read the product barcode **24** and communicate a corresponding string of characters to the controller using electrical signals.

Regardless of which type of barcode reader is used in the card loading station **60**, the controller of the ALV machine **50** individually verifies the product barcode **24** of the singulated blister card **20** against the expected pick requests from the pharmacy host. This aids in ensuring that each of the blister cards **20** processed by the card loading station **60** matches any one of the expected products **12** in the tracking data for the pick batch introduced into the product induction magazine **150**.

(d) Box Loading Station

FIGS. **16-23** illustrate the components of the box loading station **62** (FIG. **3**) in further detail. The box loading station **62** includes three main component assemblies: a loading conveyor assembly **220** onto which boxes **22** collected by an operator are deposited, an infeed conveyor assembly **222** for delivering the boxes **22** to the transfer station **64**, and a transfer assembly **224** for transferring boxes **22** from the loading conveyor assembly **220** to the infeed conveyor assembly **222**. The loading conveyor assembly **220** includes a load conveyor **230** supported by a frame **232** and readily accessible by an operator. Because the load conveyor **230** is arranged generally across the front of the ALV machine **50** (see FIG. **5**), the operator can deposit a number of the boxes **22** along the length of the load conveyor **230**.

A transfer stand **234** with a top surface **236** adjacent the load conveyor **230** is provided to increase the amount of available area for receiving the boxes **22**. The transfer stand **234** also provides an area for arranging the boxes **22** to have the same orientation before sliding them onto the load conveyor **230**. For example, the operator may drop the collected boxes **22** onto the transfer stand **234** and then arrange each of them so that a top surface **238** faces a first guide rail **240** that runs along the length of the load conveyor **230** and so that their sidewall **28** with the product barcode **24** faces upwardly. The boxes **22** can then be slid across the top surface **236** of the transfer stand **234** and onto the load conveyor **230** until their top surface **238** abuts the first guide rail **240**. Alternatively, the operator may properly orient each box **22** before depositing them directly on the load conveyor **230**. Arranging the boxes **22** to have the same orientation ensures that their product barcodes **24** follow the same workflow path.

The load conveyor **230** moves the boxes **22** in the direction generally indicated by arrows **244**. Before reaching an end **246** of the load conveyor **230**, the boxes **22** are pushed against a second guide rail **248** by a pusher assembly **250**. The pusher assembly **250** is located in line with the first guide rail **240** and includes a contact member **252** driven by a linear actuator **254** in a direction transverse to the direction **244** of the load conveyor **230**. By pushing each box **22** against the second guide rail **248**, the pusher assembly **250** ensures that the boxes **22** are similarly positioned when they reach the end **246** of the load conveyor **230**. Sensors **256**, **258**, **260** verify the position and orientation of each box **22** at the end **246** of the load conveyor **230**.

The infeed conveyor assembly **222** includes an infeed conveyor **266** generally arranged perpendicular to the load conveyor **230**. Thus, as the boxes **22** reach the end **246** of the load conveyor **230**, they must be pushed forward onto the infeed conveyor **266**. This transfer step is accomplished by the transfer assembly **224**, which includes transfer arm **270** generally parallel to the direction **244**, a first linear actuator **272** coupled to the transfer arm **270** and generally aligned in a direction perpendicular to the direction **244**, and a second linear actuator **274** coupled to the first linear actuator **272** and generally aligned in a direction parallel to the direction **244**. The transfer arm **270** extends through a slot **276** provided in a frame **278**, which includes one or more spacer plates **280** positioned above the load conveyor **230** at the end **246**. Boxes **22** that reach the end **246** of the load conveyor **230** momentarily rest against the spacer plate **280** as the load conveyor **230** continues to move underneath the boxes **22**.

In an initial position, the first and second linear actuators **272**, **274** are in extended states with transfer arm **270** is positioned adjacent the second guide rail **248**. The transfer arm **270** does not interfere with movement of the boxes **22** to the end **246** of the load conveyor **230**. After the sensors **256**, **258**, **260** verify the box **22** position and orientation, the first linear actuator **272** retracts to move the transfer arm **270** in a direction transverse to the direction **244** thereby pushing the box **22** onto the infeed conveyor **266**. The second linear actuator **274** then retracts to move the first linear actuator **272** and transfer arm away **270** from the infeed conveyor **266**. At this point, the first linear actuator **272** moves back to an extended state so that the transfer arm **270** is generally aligned with the second guide rail **248** again. Finally, the second linear actuator **274** moves back into an extended state as well so that the transfer arm **270** is adjacent the second guide rail **248** and ready to push the next box **22** that has moved to the end **246** of the load conveyor **230**. The transfer process described above is repeated for each successive box **22** on the load conveyor **230**. As a result, the arrangement of the boxes **22** is transformed from a side-by-side arrangement on the load conveyor **230** to an end-by-end arrangement on the infeed conveyor **266**.

The infeed conveyor **266** is supported by a frame **286** having guide rails **288**, **290** for directing the boxes **22** as they move in the machine direction of the infeed conveyor **266**. The boxes **22** move along the infeed conveyor **266** until they reach a box rotation mechanism **292**, which includes a bracket **294** configured to support a portion of the box **22**, a rotary actuator **296** coupled to the bracket **294**, a frame **298** supporting the rotary actuator **296**, and a linear actuator **300** for moving the frame **298** vertically. The bracket **294** initially forms a product stop for the box **22** at the end of the infeed conveyor **266**. Once a sensor **302** determines that a box **22** has reached the end of the infeed conveyor **266**, the linear actuator **300** raises the frame **298** and the rotary actuator **296** rotates the bracket **294**. This results in the box **22** being raised and rotated so that the front surface **88** is aligned in a horizontal plane (i.e., faces up) and the sidewalls **28**, **30** are aligned in vertical planes. This also results in the box **22** being elevated to a position where the product barcode **24** on the sidewall **28** can be easily read by a camera assembly **304**.

To this end, the camera assembly **304** includes a pair of shafts **310**, **312** that support a camera mount **314** having a lighting assembly **316** and camera cover **318** attached thereto. The lighting assembly **316** is positioned so that a lighting device **317** emits light onto the product barcode **24** of the box **22** after it has been raised and rotated by the box rotation mechanism **292**. The camera cover **318** is configured to support a camera **320** that faces the product barcode **24** in this position. Similar to the camera assembly **152** of the card loading station **60**, the camera **320** takes images of the product barcode **24** that are analyzed by the controller using machine vision software. The camera **320** may also be replaced with a laser scanner (not shown) in alternative embodiments. Regardless of which type of barcode reader is used, the ALV machine **50** individually verifies the product barcode **24** of the boxes **22** against the expected pick requests from the pharmacy host. This aids in ensuring that each of the boxes **22** processed by the box loading station **62** matches any one of the expected products **12** in the tracking data for the pick batch.

(e) Transfer Station and Dial Conveyor

With reference to FIGS. **3**, **24**, and **25**, the transfer station **64** is generally represented by the robot **66**, which is illustrated as having a SCARA (selective compliance assembly robot arm) configuration. The robot **66** includes a base **326**, a first arm **328** pivotally coupled to the base **326** in an X-Y direction, and a second arm **330** pivotally coupled to the first arm **328** in the X-Y direction. An end effector or wrist **332** associated with the first arm **328** is configured to move in a Z-direction and pick up products **12** having the different form factors. More specifically, the end effector **332** includes gripping members **334**, **336** that move toward each other to grasp the sidewalls **28**, **30** of one of the boxes **22** and suction members **338***a*, **338***b* that are operated by a vacuum source (not shown) to establish and maintain engagement with the front surface **26** of one of the blister cards **20**. In one specific embodiment, the robot **66** may be an Adept Cobra™ SCARA robot available from Adept Technologies, Inc. Other robot configurations, such as a Cartesian configuration, may be used in alternative embodiments. Those skilled in the art will appreciate that regardless of the configuration, the robot **66** may include various motion controller and electronic system devices, such as limit switches, sensors, input/output terminals, amplifiers, pneumatic valves, fittings, solenoids, power supplies, programmable controllers, servo motors, and belt pulley drives for performing the required movements.

As discussed above, the card loading station **60** delivers blister cards **20** and the box loading station **62** delivers boxes **22** to respective locations that are readily accessible by the robot **66**. Products **12** that have failed verification and been signaled as rejects are gripped and transferred by the robot **66** into the first reject bin **70** (FIG. **5**). The robot **66** deposits rejected products **12** in an organized manner that makes efficient use of available space. For example, as shown in FIG. **45**, blister cards **20** and boxes **22** (shown as overlapping for the purpose of explanation) placed by the robot **66** may be stacked on top of or deposited immediately adjacent to other blister cards **20** or boxes **22**. An increased number of blister cards **20** and boxes **22** can be deposited into the first reject bin **70** when providing such an organized arrangement than when randomly depositing rejected blister cards **20** and boxes **22** into the first reject bin **70**.

Products **12** that have been successfully verified at either the card loading station **60** or box loading station **62** are gripped and transferred by the robot **66** onto a base plate **344** (FIG. **26**) of a product nesting assembly **346** carried by the dial conveyor **68**. There are a total of eight base plates **344** (and corresponding product nesting assemblies **346**) on the dial conveyor **68** so that the ALV machine **50** can simultaneously process multiple products **12**, with different products **12** undergoing different processing steps. The dial conveyor **68** rotates so that the base plates **344** follow a circular workflow path, but pauses after each $1/8^{th}$ turn to allow time to process the products **12** at the various stations located in the workflow path. Thus, there are a total of eight indexed locations associated with the workflow path of the dial conveyor **68**. The two locations within the transfer station **64** schematically outlined in FIG. **3** are where the robot **66** deposits the verified products **12**.

As shown in FIGS. **27-30**, each nesting assembly **346** is advantageously configured to support and stabilize products **12** having different form factors. The nesting assemblies **346** each include the base plate **344** supported on the dial conveyor **68** and a pin plate **350** hanging below the dial conveyor **68**. The base plate **344** is generally planar, but has several card locating pins **352** spaced about its periphery and extending upwardly. The card locating pins **352** help define a bounded area on the base plate **344** for containing blister cards **20** deposited by the robot **66**. Thus, the robot **66** places blister cards **20** into the area between the card locating pins **352**, which prevent the deposited blister card **20** from shifting on the base plate **344** as it is processed in the workflow path of the dial conveyor **68**.

The pin plate **350** is configured to be received in a window or opening (not shown) of the dial conveyor **68** below the base plate **344**. In an initial position, however, the pin plate **350** hangs below the window and rests on opposed supports **358**, **360** suspended from the base plate **344** by respective pairs of guide shafts **362**, **364**. The pin plate **350** is movable along the guide shafts **362**, **364** and includes box locating pins **366** of various sizes extending upwardly toward the base plate **344**. The box locating pins **366** are configured to extend through holes **368** in the base plate **344** when the pin plate **350** is moved upwardly along the pairs of guide shafts **362**, **364** and into the window of the dial conveyor **68**. When moved to such a position, the box locating pins **366** help define a bounded area on the base plate **344** for containing boxes **22** placed by the robot **66**. Thus, the box locating pins **366** are analogous to the card locating pins **352** in that they prevent the deposited box **22** from shifting on the base plate **344** as it is processed in the workflow path of the dial conveyor **68**. The pin plate **350** also includes a downwardly extending shaft **370** that terminates in a flange **372**.

With reference to FIGS. **26** and **31**, the ALV machine **50** includes two lifting assemblies **374** for controlling the vertical movement of the pin plates **350** at the two indexed locations associated with the transfer station **64**. Each lifting assembly **374** includes a vertical motion mechanism **376** in the form of a linear actuator, an adaptor collar **378** driven by the vertical motion mechanism **376**, and a guide plate **382** mounted to a support post **384** for guiding movement of the vertical motion mechanism **376**. The adaptor collar **378** is generally a U-shaped bracket having a base **386**, opposed arms **388**, **390** extending upwardly from the base **386**, and opposed upper portions **392**, **394** extending inwardly from the opposed arms **388**, **390**. A gap exists between the opposed upper portions **392**, **394** to accommodate the downwardly extending shaft **370** of each nesting assembly **346**, and the width between the opposed arms **388**, **390** is greater than the flange **372** of each nesting assembly **346**. Therefore, when the dial conveyor **68** has moved a nesting assembly **346** to one of the indexed locations in the workflow path where the lifting assembly **374** is present, the shaft **370** of the nesting assembly **346** extends through the gap of the associated adaptor collar **378** so that the flange **372** is positioned between the opposed arms **388**, **390**. The flange **372** is located near the base **386** of the adaptor collar **378** when the pin plate **350** is in an initial, lower position. If one of the verified boxes **22** is going to be placed onto the associated base plate **344**, the vertical motion mechanism **376** drives the adaptor collar **378** upwardly. As a result, the base **386** of the adaptor collar **378** contacts the flange **372** and, through the shaft **370**, pushes the pin plate **350** toward the base plate **344** until the box locating pins **366** extend through the holes **368** and define the area for containing the box **22**.

The nesting assembly **346** includes various components that maintain the pin plate **350** in a raised position even after the dial conveyor **68** moves it to another indexed location. The nesting assembly **346** is able to freely move away from the lifting assembly **374** because of the adaptor collar **378** returns to a home position. More specifically, in the raised position of the pin plate **350** and adaptor collar **378**, the flange **372** remains positioned below a plane including the opposed supports **358**, **360**. The vertical motion mechanism **376** retracts the adaptor collar **378** to a home position in which the upper portions **392**, **394** are vertically positioned between the supports **358**, **360** and the flange **372**. The nesting assembly **346** is then free to move without interference from the lifting assembly **374**, with the shaft **370** and flange **372** passing through the adaptor collar **378** because of its open configuration.

After the box **22** has been processed and removed from the dial conveyor **68**, the pin plate **350** remains in the raised position. If a blister card **20** is to be deposited on the nesting assembly **346** during the next cycle of the dial conveyor **68**, the box locating pins **366** must be retracted from the base plate **344**. This is accomplished by moving the adaptor collar **378** to a lowered position. In particular, when the nesting assembly **346** is returned to one of the two indexed locations in the workflow path of the dial conveyor **68** where verified products **12** may be deposited, the shaft **370** and flange **372** are received between the arms **388**, **390** of the adaptor collar **378**. This is once again the result of the open configuration of the adaptor collar **378**. At this point, the vertical motion mechanism **376** moves the adaptor collar **378** downwardly to the lowered position. The opposed upper portions **392**, **394** of the adaptor collar **378** engage the flange **372** during this downward movement to pull the pin plate **350** away from the base plate **344** and into its lowered position. The vertical motion mechanism **376** can then return the adaptor collar **378** to its home position without the base **386** contacting the flange **372**.

(f) Labeling Station

The first station located in the workflow path of the dial conveyor **68** that processes the products **12** once they are positioned on one of the base plates **344** is the labeling station **76**. With reference to FIGS. **32-42**, the labeling station **76** includes the label printer **78**, the label applicator **80**, the label reject device **82**, and a flattening device **400**. The label printer **78** may comprise any commercial type of label printer **78**, and is an ACCRAPLY S8400 Series label printer available from Barry-Wehmiller Companies, Inc. in one specific embodiment. The label printer **78** is mounted on a table **408** and includes a large capacity label feed roll and a large capacity backing take-up roll. The table **408** is supported by a cart **402** that enables the label printer **78** to be moved to various locations without the need for physical lifting. Releasable clamp mechanisms **406** fix the table **408** to the cart **402**, and releasable clamp mechanisms **404** fix the cart **402** to the ALV machine **50**.

The label printer **78** features a "Plug-and-Play" design so that, in the event of a printer failure or malfunction, the label printer **78** can be easily and quickly replaced with a spare label printer **78**. The electrical connections for the label printer **78** with the ALV machine **50** feature releasable connectors (not shown) that promote the rapid replacement. If the label printer **78** fails or malfunctions, the operator releases the clamp mechanisms **404**, unplugs the electrical connectors, and wheels the failed label printer **78** away from the ALV machine **50** on the cart **402**.

As best shown in FIGS. **34-36**, the label applicator **80** of the labeling station **76** includes a tamp block **410**, a vacuum tamp head **412** carried by the tamp block **410**, an actuator **414** that moves the tamp block **410** vertically, a mounting arm **416** coupled to the actuator **414**, and a pair of support shafts **418**, **420** that elevate the mounting arm **416** above the dial conveyor **68**. The tamp head **412** is configured to temporarily capture each patient label **32** (FIGS. **6** and **7**) printed by the label printer **78**. Specifically, the tamp head **412** is configured to apply suction to the non-adhesive side of the patient label **32** so that the patient label **32** is temporarily retained against a tamp pad **422** with the adhesive side facing downward toward the product **12**. A window **424** extending through the tamp head **412** is aligned with the patient barcode **34** when the patient label **32** is retained against the tamp pad **422**. The window **424** thus permits the patient barcode **34** to be viewed and verified prior to being applied on the product **12**.

To this end, the label applicator **80** further includes a camera cover **430** and mounting plate **432** coupled to the mounting arm **416**. The camera cover **430** is configured to support a camera **436** that captures images of the patient barcode **34** through the window **424**. A lighting assembly **434** mounted to the flattening device **400** directs light toward the patient barcode **34** to supplement ambient lighting and facilitate the imaging process. Using machine vision software, the controller of the ALV system **10** analyzes the images captured by the camera **436** of the label applicator **80** to determine if the patient barcode **34** has been successfully printed on the patient label **32**. If the product barcode **24** cannot be read or otherwise fails verification, the patient label **32** is flagged for application to the label reject device **82**. If the patient barcode **34** is successfully read and verified, the patient label **32** is flagged for application to the product **12**.

The label applicator **80** applies the patient labels **32** to the products **12** by causing the actuator **414** to move the tamp block **410** and tamp head **412** downwardly toward the product **12**. The label reject device **82** includes a reject plate **440** having a portion initially positioned between the tamp head **412** and product **12** in this path of motion. When a patient label **32** has been flagged as a reject, the reject plate **440** remains in this position so that the tamp head **412** contacts the reject plate **440** rather than the product **12**. The actuator **414** pushes the tamp head **412** against the reject plate **440** with sufficient force to establish an adhesive bond between the patient label **32** and the reject plate **440**. As a result, the actuator **414** can then move the tamp head **412** back to its initial position with the patient label **32** remaining on the reject plate **440**.

Eventually a stack **442** of patient labels **32** that fail verification will accumulate on the reject plate **440**. It may be necessary to periodically replace clear the reject plate **440** of these non-verified patient labels **32**. A sensor **444** associated with the label reject device **82** determines when the stack **442** has reached a maximum acceptable level (generally designated by line **446**). The controller of the ALV system **10** processes signals received from the sensor **444** to notify an operator to remove the stack **442**.

When a patient label **32** has been successfully verified and flagged for application to the product **12**, an actuator **414** moves the reject plate **440** out of the path of motion of the tamp head **412**. The tamp head **412** then moves downwardly through a window **450** provided in a support plate **452** of the flattening device **400** before reaching the product **12**. When the product **12** is a box **22**, the tamp head **412** presses the patient label **32** against the front surface **88** with sufficient force to establish an adhesive bond but not crush or damage the box **22**. The tamp head **412** and patient label **32** have a width greater than the front surface **88**, and the box **22** is centered under the tamp head **412**. As a result, only a portion of the patient label **32** is adhesively bonded to the box **22** during this label application step. The actuator **414** returns the tamp head **412** to its initial position, leaving the patient label **32** extending across the front surface **88** with portions projecting outwardly from the front surface **88** above the opposed sidewalls **28**, **30**. These portions are flattened, or "wiped," onto the sidewalls **28**, **30** at the label wipe station **90**, as will be described below. The camera of the label applicator **80** may be used to verify that the patient label **32** is still not attached to the tamp head **412** prior to moving the box **22** to the label wipe station **90**.

When the product **12** at the labeling station **76** is a blister card **20**, the flattening device **400** stabilizes the blister card **20** on the base plate **344** when applying the patient label **32**. The flattening device **400** includes a pair of fingers **460**, **462** rotatably supported above opposite sides of the base plate **344** at the labeling station **76**. The fingers **460**, **462** are coupled to respective actuators **464**, **466**, which are shown in the form of air cylinders. The actuators **464**, **466** rotate the fingers **460**, **462** toward the blister card **20** to push the blister card **20** against the base plate **344**. Thus, the blister card **20** is firmly gripped between the fingers **460**, **462** and base plate **344** to prevent movement of the blister card **20** during the label application process.

The patient labels **32** are applied to the blister cards **20** in a manner similar to the boxes **22**. Namely, the tamp head **412** moves downwardly through the window **450** of the support plate **452** until it presses against the front surface **26** of the blister card **20**. Because the entire application area, or landing zone, for the patient label **32** is located on the front surface **26**, the patient label **32** is applied entirely flat onto the front surface **26** (there are no projecting portions that must be wiped onto other surfaces). When the tamp head **412** is retracted, the camera of the label applicator **80** may again be used to verify that the patient label **32** is still not attached to the tamp head **412**. The actuators **464**, **466** rotate the fingers **460**, **462** away from the blister card **20** when tamp head **412** is retracted, permitting the dial conveyor **68** to transfer the blister card **20** to the next processing station.

(g) Label Wipe Station

Once a patient label **32** has been applied to a product **12**, the dial conveyor **68** is rotated to bring the product **12** to the label wipe station **90**. As shown in FIGS. **41** and **42**, the label wipe station **90** includes a label wiping device **472** having a pair of wiping fingers **474**, **476** suspended above the products **12**. The label wiping fingers **474**, **476** are generally rectangular elements arranged parallel to each other and spaced apart by a distance approximately equal to the width of one of the boxes **22**. Mounting plates **478** and **480** couple the label wiping fingers **474**, **476** to a vertical motion mechanism **482**, which in turn is coupled to a mounting plate **484** supported by a pair of vertical support shafts **486**, **488**. The label wiping device **472** also includes a gripping element **490** having gripping fingers **492**, **494** that initially project in a horizontal direction.

A sensor (not shown) determines whether a blister card **20** or box **22** is located at the label wipe station **90**. If a blister card **20** is present, the label wiping device **472** does not perform any processing steps. As mentioned above, the patient label **32** is initially applied flat onto the front surface **26** of the blister card **20** so that no wiping is necessary. The blister cards **20** are temporarily positioned at the label wipe station **90** without further processing until the dial conveyor **68** is further rotated to move the blister card **20** to the next indexed location in the workflow path.

Boxes **22** brought to the label wipe station **90** have the patient label **32** applied to the front surface **88** with portions of the patient label **32** projecting outwardly over the sidewalls **28**, **30**. When the sensor detects a box **22**, the gripping fingers **492**, **494** of the gripping element **490** rotate downwardly to grip the sidewalls **28**, **30** of the box **22**. With the box **22** stabilized by the gripping element **490**, the vertical motion mechanism **482** moves the mounting plates **478**, **480** and label wiping fingers **474**, **476** downwardly over the box **22**. The label wiping fingers **474**, **476** closely receive the box **22** therebetween. Thus, during the downward movement, the label wiping fingers **474**, **478** contact the projecting portions of the patient label **32** and push them downwardly to create a fold along the side edges of the front surface **88**. The projecting portions of the patient label **32** are effectively "wiped" onto the sidewalls **28**, **30** of the box **22**. At this point, the gripping element **490** rotates the gripping fingers **492**, **494** back to their initial position and the vertical motion mechanism **482** retracts the label wiping fingers **474**, **476**. The box **22** is now ready to be further processed with the patient label **32** wrapped around the front surface **88** and sidewalls **28**,**30**.

(h) Vision Inspection Station

The next indexed location in the workflow path of the dial conveyor **68** is the vision inspection station **92**. With reference to FIG. **43**, the vision inspection station **92** includes various mounting plates **502**, **504**, **506** supported above the dial conveyor **68** by vertical support shafts **508**, **510**, **512**, **514**. A first camera guard **516** is coupled to the mounting plate **502** and aligned in a generally vertical direction. The first camera guard **516** is configured to support an overhead camera **517** that inspects both the product barcode **24** and the patient barcode **34** on the blister cards **20**. Thus, both the product barcode **24** and patient barcode **34** are within the field of view of the overhead camera **517**. A lighting assembly **518** may also be suspended above the dial conveyor **68** to assist with this imaging process. As such, the lighting assembly **518** is configured to direct light toward the patient barcode **34** and product barcode **24** on the blister card **20**. Those skilled in the art will appreciate that separate cameras (not shown) may be used in alternative embodiments to read the product barcode **24** and patient barcode **34**.

The vision inspection station **92** further includes a second camera guard **524** coupled to the mounting plate **504** and a third camera guard **526** coupled to the mounting plate **506**. The second and third camera guards **524**, **526** are aligned in a generally horizontal direction and suspended only slightly above the dial conveyor **68**. The second camera guard **524** is configured to support a camera **525** that reads the patient barcode **24**, which, as a result of the label wipe station **90**, is positioned on the sidewall **28** of the box **22**. The third camera guard **526** is configured to support a camera **527** that reads the product barcode **34** on the sidewall **28** of the box **22**. One or more lighting assemblies **528** may be suspended above the dial conveyor **68** proximate the first and second camera guards **524**, **526**. The lighting assemblies **528** are configured to illuminate the patient barcode **34** and product barcode **24** to facilitate the imaging process.

The controller of the ALV system **10** analyzes the images taken by the cameras **517**, **525**, **527** of the vision inspection station **92**. If the product barcode **24** and patient barcode **34** match, the product **12** is flagged as an accepted item. If the product barcode **24** and patient barcode **34** do not match or cannot be read, the product **12** is flagged as a reject.

(i) Unloading Station

The unloading station **94** of the ALV machine **50** is generally represented by the robot **96**, as shown in FIG. **44**. Like the robot **66** of the transfer station **64**, the robot **96** of the unloading station **94** in the representative embodiment has a SCARA configuration. Indeed, the robot **96** may be the same model (e.g., an Adept Cobra™ robot) as the robot **66** of the transfer station **64** so as to operate in the same manner to move the blister cards **20** and boxes **22** from one location to another. Accordingly, like reference numbers are used in FIG. **44** to refer to like structure from the robot **66**, and reference can be made to the description of the robot **66** for a more complete understanding of how these components operate to "pick and place" the blister cards **20** and boxes **22**.

Products **12** flagged as rejects at the vision inspection station **92** are picked up by the robot **96** when they reach the unloading station **94** and placed into the second reject bin **98**. The first and second reject bins **70**, **98** are located in respective drawers or compartments (see FIG. **4**) of the ALV machine **50**. One or both of the first and second reject bins **70**, **98** may be locked by a key or code. Thus, only individuals with the proper authority can access the rejected products **12**, which is a safety feature of the ALV system **10**.

Products **12** that have been successfully verified and flagged as accepted items at the vision inspection station **92** are picked up by the robot **96** and deposited in one of the containers **54** on the main conveyor **106** of the tote conveyor system **52**. As shown in FIG. **45**, the robot **96** may deposit rejected and accepted products **12** in an organized manner that makes efficient use of available space.

(j) Tote Conveyor System and Tote Handling System

FIGS. **46**-**53** illustrate components of the tote conveyor system **52** and tote handling system **56** in further detail. The tote conveyor system **52** includes a tote loading apparatus **540** designed to singulate stacks of the containers **54** onto the main conveyor **106**. The tote loading apparatus **540** may be, for example, the Tote Tender™ handling system available from Total Tote, Inc. Such a system de-stacks large volumes of containers **54** at high rates. Thus, in use, an operator places stacks of the containers **54** on a feed conveyor **542** that supplies stacks to the tote loading apparatus **540**. The tote loading apparatus **540** then de-stacks the containers **54**, one at a time, and supplies them to the main conveyor **106**.

The containers **54** include a container barcode (not shown) on one side so that attributes (e.g., a customer facility) can be assigned to the containers **54**, and so that labeled and verified products **12** can be checked against the container **54**. When loading stacks of the containers **54** onto the feed conveyor **542**, an operator ensures that the container barcodes face the same direction. One or more barcode readers **550** positioned along the main conveyor **106** are configured to track the status of the containers **54** after they have been de-stacked by the tote loading apparatus **540**. The main conveyor **106** may also include various sensors (not shown) to monitor the location of the containers **54**. These sensors enable the main conveyor **106** to stop the containers **54** at the unloading station **94** of the ALV machine **50**, where they may be filled with labeled and verified products **12** by the robot **96**.

Once the containers **54** are filled, the main conveyor **106** then transports the container **54** to a secondary conveyor **552**. If the container **54** has been flagged for auditing, the secondary conveyor **552** transfers the container **54** to the parallel conveyor **108** for delivery to the audit station **100**. The audit station **100** includes a hand-held barcode scanner (not shown) and an operator's interface (e.g., a computer monitor). An operator at the audit station **100** scans the product barcodes **24**, patient barcodes **34**, and the container barcode to check whether the patient labels **32** have been applied to the correct products **12** and whether the products **12** have been placed into the correct container **54**.

If the container **54** has not been flagged for auditing, the secondary conveyor **552** transfers the container **54** to the tote handling system **56**. The tote handling system **56** includes a loading queue or conveyor **560** that receives the containers **54** from the secondary conveyor **552**, in addition to the tote load robot **110** and the tote rack **112**. In one specific embodiment, the tote load robot **110** is a six-axis Adept Viper™ robot available from Adept Technologies, Inc. The tote load robot **110** is configured to pick the containers **54** up from the loading conveyor **560** and place them either onto the tote return conveyor **114** for delivery to the audit station **100** or onto the tote rack **112** for temporary storage. The tote rack **112** includes shelves **562** divided into separate lanes **564** for storing the containers **54**. The lanes **564** are inclined from the front of the tote rack **112**, which is accessible by operators, to the rear of the tote rack **112**, which is accessible by the tote load robot **110**. Because the lanes **564** each comprise a plurality of rollers **566**, containers **54** deposited by the tote load robot **110** are able to travel along the lanes **564** to the front of the tote rack **112**. Stops **568** positioned at the front of the tote rack **112** prevent the containers **54** from falling off the shelves **562**.

The components of the ALV system **10** described in detail above are merely representative in nature. Those skilled in the art will appreciate that other components may be used to process products **12** in a manner similar to the ALV system **10**.

In summary, the ALV system **10** opportunistically relies on the two common form factors, namely blister cards **20** or boxes **22** of solid dosages, to improve efficiency and to automate a labeling and verification process. The ALV system **10** processes and optimizes pharmacy verification or post-adjudicated orders/pick requests, verifies that the correct patient label **32** is placed on the correct product **12**, and verifies that the correct product **12** is placed into the correct container **54**, without any damage either to the product **12** or to the patient label **32**. The labeled and verified products **12** may include any combination of blister cards **20** and boxes **22**, along with other potential form factors. The ALV system **10** reduces medication errors associated with manual distribution, lowers costs associated with pharmaceutical distribution, permits reductions in personnel, and improves inventory control.

While the invention has been illustrated by a description of various embodiments and while these embodiments have been described in considerable detail, it is not the intention of the applicants to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications, along with component substitutions, will readily appear to those skilled in the art. For example, wherever a "camera" is discussed in this specification, those skilled in the art will appreciate that other types of barcode readers may be used by the ALV system **10**. Thus, the invention in its broader aspects is therefore not limited to the specific details, representative apparatus and method, and illustrative example shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of applicants' general inventive concept.

What is claimed is:

1. An apparatus for filling a customer order with a plurality of products each containing a pharmaceutical and each marked with a product barcode, the apparatus comprising:
- a dial conveyor defining a circular workflow path for processing the products;
- a label application station arranged about the circular workflow path of the dial conveyor and configured to print and apply a patient label onto each of the products;
- a vision inspection station arranged about the circular workflow path of the dial conveyor, the vision inspection station configured to independently verify that the product barcode on each of the products matches a patient barcode on the patient label after application to the product; and
- an unloading station configured to transfer labeled and verified products away from the conveyor.

2. The apparatus of claim **1** further comprising:
- a product loading station configured to receive batches of the products, the product loading station further configured to singulate the products in each of the batches.

3. The apparatus of claim **2** wherein the product loading station includes a barcode reader configured to read the product barcode on each of the products.

4. The apparatus of claim **2** wherein the product loading station is configured to process products shaped with a card form factor, and the product loading station comprises:
- a product induction magazine defining a feed chute configured to receive a stack of the products shaped with the card form factor;
- a landing plate defining a bottom of the feed chute and configured to support the stack of the products shaped with the card form factor; and
- a gripping device movable relative to the landing plate, the gripping device configured to cooperate with the product induction magazine to successively singulate each of the products from the stack.

5. The apparatus of claim **2** wherein the product loading station is configured to process products shaped with a box form factor, and the product loading station comprises:
- a load conveyor configured to move products shaped with the box form factor that have placed on the load conveyor;
- an infeed conveyor arranged generally perpendicular to the load conveyor; and
- a transfer arm configured to move the products from the load conveyor to the infeed conveyor.

6. The apparatus of claim **5** wherein the box loading station further comprises:
- a box rotation mechanism including a bracket configured to support at least a portion of one of the products moved by the infeed conveyor, a rotary actuator coupled to the bracket, a frame supporting the rotary actuator, and a linear actuator configured to move the frame vertically.

7. The apparatus of claim **2** further comprising:
- a transfer station configured to transfer the products from the product loading station to the conveyor.

8. The apparatus of claim **7** further comprising:
- a control system operatively connected with the conveyor, the product loading station, the transfer station, the label application station, the vision inspection station, and the unloading station, the control system configured to control the filling of the customer order by the stations.

9. The apparatus of claim **7** wherein the transfer station comprises:
- at least one robot configured to pick the products up from the product loading station and place the products on the conveyor.

10. The apparatus of claim **9** further comprising:
- a reject bin positioned adjacent the conveyor, the at least one robot configured to pick the products up from the product loading station and place the products in the reject bin.

11. The apparatus of claim **1** further comprising:
- a card loading station configured to receive and singulate batches of the products shaped with a card form factor; and
- a box loading station configured to receive and singulate batches of the products shaped with a box form factor.

12. The apparatus of claim **1** wherein the label application station is configured to independently verify the patient barcode on the patient label before the patient label is applied to one of the products.

13. The apparatus of claim **1** wherein the label application station comprises:
- a label printer configured to print the patient labels;
- an applicator configured to temporarily capture the patient labels from the label printer and move the patient labels along a path of motion toward the product being processed by the label application station; and

a reject plate selectively movable between a first position in the path of motion of the applicator and a second position out of the path of motion, the applicator configured to apply each of the patient labels to one of the products or to the reject plate.

14. The apparatus of claim **13** wherein the applicator includes a tamp head having a window configured to be aligned with the patient barcode on the patient label, and wherein the label application station further comprises:

a barcode reader configured to read the patient barcode through the window before the patient label is applied to one of the products being processed or the reject plate.

15. The apparatus of claim **13** wherein the products are shaped with at least two different form factors, and the applicator is configured to apply each of the patient labels to the products of the different form factors.

16. The apparatus of claim **1** further comprising:

a label wipe station including a sensor configured to detect whether the product being processed is shaped with a box form factor and a pair of wiping fingers suspended above the conveyor, the wiping fingers being generally parallel to each other and movable toward the conveyor to further apply portions of each patient label on products shaped with the box form factor.

17. The apparatus of claim **1** wherein the products are shaped with a card form factor or a box form factor, and the vision inspection station comprises:

a first barcode reader configured to read the product barcode and patient barcode on the products shaped with the card form factor;

a second barcode reader configured to read the product barcode on the products shaped with the box form factor; and

a third barcode reader configured to read the patient barcode on the products shaped with the box form factor.

18. The apparatus of claim **1** further comprising:

a tote conveyor system configured to supply containers into which labeled and verified products are placed.

19. The apparatus of claim **18** further comprising:

a tote handling system configured to manage the containers after the containers have been filled with labeled and verified products, the tote handling system including a loading conveyor configured to receive the containers from the tote conveyor system, a tote rack having shelves divided into lanes for storing the containers, and a robot configured to pick each container up from the loading conveyor and place the container in one of the lanes of the tote rack.

20. The apparatus of claim **1** wherein the unloading station further comprises:

at least one robot configured to remove the products from the conveyor after the products have been labeled and verified.

21. A method of filling a customer order with a plurality of products each containing a pharmaceutical, the products being loaded into a machine for processing, the method comprising:

automatically verifying a product barcode on each of the products with the machine;

transferring the products with a verified product barcode onto a dial conveyor that defines a circular workflow path for processing the products in the machine;

printing a patient label for each of the products processed in the machine;

applying the patient labels to the products processed in the machine; and

after the patient label is applied to each of the products, independently verifying that the product barcode matches a patient barcode on the patient label.

22. The method of claim **21** further comprising:

singulating batches of the products loaded into the machine so that the products can be individually processed by the machine.

23. The method of claim **22** wherein singulating batches of the products further comprises:

singulating batches of products shaped with a card form factor in a first product loading station; and

singulating batches of products shaped with a box form factor in a second product loading station.

24. The method of claim **21** wherein automatically verifying a product barcode on each of the products with the machine further comprises:

reading the product barcode on each of the products after each product has been loaded into a product loading station of the machine; and

comparing the product barcode to tracking data to verify that the product belongs in the customer order being filled.

25. The method of claim **24** wherein the products with the verified product barcode are transferred from the product loading station onto the dial conveyor.

26. The method of claim **24** further comprising:

transferring the products with a product barcode that fails verification from the product loading station into a reject bin positioned adjacent the dial conveyor.

27. The method of claim **24** wherein transferring the products with the verified product barcode further comprises:

picking the products up from the product loading station with a robot; and

placing the products onto a designated location on the dial conveyor.

28. The method of claim **21** wherein the patient labels are printed by a label printer, and applying the patient labels further comprises:

temporarily capturing each patient label with an applicator after the patient label has been printed, the applicator being suspended above the product being processed; and

moving the applicator and the patient label captured by the applicator along a path of motion toward the product being processed.

29. The method of claim **28** further comprising:

reading the patient barcode while the patient label is temporarily captured by the applicator to verify the patient label.

30. The method of claim **29** further comprising:

applying patient labels with a patient barcode that fails verification onto a reject plate located in the path of motion of the applicator; and

moving the reject plate out of the path of motion when the patient label captured by the applicator has a verified patient barcode so that the patient label can be applied to the product being processed.

31. The method of claim **28** wherein applying the patient labels further comprises:

retaining the patient labels on a tamp head with each patient label arranged so that the patient barcode is generally aligned with a window in the tamp head; and

reading the patient barcode through the window of the tamp head.

32. The method of claim **28** wherein applying the patient labels to at least some of the products further comprises:

applying the patient labels with the applicator to at least one of the products shaped with a card form factor; and applying the patient labels with the applicator to at least one of the products shaped with a box form factor.

33. The method of claim **31** wherein each patient label applied to the products shaped with the box form factor is applied to a front surface of the box with portions of the patient label projecting outwardly from the front surface above opposed sidewalls of the box, and the method further comprises:

wiping the projecting portions of the patient label onto the opposed sidewalls of the box with a pair of wiping fingers.

34. The method of claim **21** wherein independently verifying the product barcode and patient barcode further comprises:

reading the product barcode and the patient barcode on each product with one or more barcode readers;

comparing the product barcode read from each product to tracking data to verify that the product belongs in the customer order being filled; and

comparing the patient barcode read from each product to tracking data to verify that the correct patient label has been applied to the correct product.

35. The method of claim **34** wherein reading the product barcode and patient barcode on each product with one or more barcode readers further comprises:

reading the product barcode and the patient barcode on each product shaped with a card form factor with a first barcode reader;

reading the product barcode on each product shaped with a box form factor with a second barcode reader; and

reading the patient barcode on each product shaped with the box form factor with a third barcode reader.

36. The method of claim **21** further comprising:

transferring products with the product barcode and the patient barcode that have been independently verified after the patient label is applied from the machine into a container on a conveyor system.

37. The method of claim **36** further comprising:

transferring products with the patient barcode or the product barcode that fail verification, after the patient label is applied, into a reject bin located in the machine.

38. The method of claim **36** wherein transferring products with the product barcode and the patient barcode that have been independently verified further comprises:

picking the products up from a surface of the machine with a robot; and

placing the products into the container with a desired orientation.

39. An apparatus for filling a customer order with a plurality of products each containing a pharmaceutical, the apparatus comprising:

a product loading station configured to receive batches of the products, the product loading station further configured to singulate the products for subsequent movement along a workflow path;

a first verification station configured to receive the products singulated by the product loading station, the first verification station including a barcode reader configured to read a product barcode on each of the products and a transfer arm configured to remove the products from the workflow path;

a label printing station configured to receive the products not removed from the workflow path by the transfer arm, the label printing station including a label printer configured to print patient labels and an applicator configured to apply each patient label on one of the products; and

a second verification station configured to receive the products from the label printing station, the second verification station including a barcode reader configured to read the product barcode on each of the products and a patient barcode on each of the patient labels, the second verification station further including a transfer arm configured to remove the products from the workflow path.

40. The apparatus of claim **39** wherein the labeling station is configured to independently verify the patient barcode printed on the patient label before the patient label is applied to one of the products.

41. The apparatus of claim **39** wherein the product loading station, the first verification station, the labeling station, and the second verification station are configured to process products shaped with at least two different form factors.

42. The apparatus of claim **39** further comprising:

a dial conveyor configured to serially transfer the products to the label printing station and the second verification station along the workflow path.

43. An apparatus for processing products shaped with at least two different form factors and each containing a pharmaceutical to fulfill a customer order, the apparatus comprising:

a machine defining a workflow path for the products shaped with the at least two different form factors; and

a plurality of automated stations arranged relative to the workflow path of the machine, the automated stations configured to automatically apply a label to each of the products shaped with the at least two different form factors and to automatically verify that each of the products belongs to the customer order.

44. The method of claim **43** wherein the machine includes a dial conveyor, and the workflow path of the machine is circular as defined by the dial conveyor.

45. A method of filling a customer order with a plurality of products each containing a pharmaceutical, the method comprising:

generating pick requests for the products with a pharmacy host server;

transmitting the pick requests to an automated dispensing system;

managing the pick requests with the automated dispensing system to generate pick batches for containers to be filled with products, the pick batches representing products to be loaded into the automated dispensing system; and

operating the automated dispensing system to automatically process the products and place the products into the containers.

46. The method of claim **45** wherein managing the pick requests with the automated dispensing system further comprises:

applying sortation rules to the pick requests to generate the pick batches; and

controlling the operation of the automated dispensing system based upon the pick batches.

47. The method of claim **46** wherein controlling the operation of the automated dispensing system further comprises:

determining whether the pick batches substantially fill a shipping tote for delivery to a customer facility.

48. The method of claim **46** wherein controlling the automated dispensing system further comprises:

switching the automated dispensing system between a mode of operation wherein the products are placed into shipping totes for delivery to a customer facility, a mode of operation wherein the products are placed into processing totes that represent partial orders for the customer facility, and a mode of operation wherein the products are placed into containers representing a storage area in a pharmacy.

49. The method of claim **45** wherein operating the automated dispensing system further comprises:

automatically verifying that the products loaded into the automated dispensing system belong in the pick batch being processed;

automatically printing and applying a patient label to the products; and

automatically verifying that the patient label has been applied to the correct product.

50. The method of claim **49** wherein automatically verifying that the patient label has been applied to the correct product further comprises:

independently verifying that each product belongs in the pick batch being processed.

51. The method of claim **45** wherein operating the automated dispensing system further comprises:

operating the automated dispensing system in a mode wherein the products are placed into shipping totes for delivery to a customer facility.

52. The method of claim **45** further comprising:

operating the automated dispensing system in a mode wherein the products are placed into processing totes that represent partial orders for a customer facility; and

combining the products from at least two of the processing totes filled by the automated dispensing system into a common shipping tote for delivery to a customer facility.

53. The method of claim **52** wherein combining the products from at least two of the processing totes filled by the automated dispensing system into a common shipping tote further comprises:

a) reading a barcode on one of the processing totes with a barcode reader;

b) reading a barcode on the shipping tote;

c) placing the products from the one processing tote into the shipping tote; and

d) repeating steps a-c for each additional processing tote containing additional products to be placed into the shipping tote.

54. The method of claim **53** wherein barcodes on the products are not individually scanned when combining the products of at least two of the processing totes.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 8,215,540 B2
APPLICATION NO. : 12/235173
DATED : July 10, 2012
INVENTOR(S) : Michael J. Szesko et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

At column 5, line 28, change “packaged” to --packages--.

At column 7, line 48, change “conveyors” to --conveyor-- and at line number 64, after “used” insert --to--.

At column 9, line 36, after “it” insert --is-- and at line number 61, after “in” delete “the”.

At column 14, line 67, after “270” delete “is”.

At column 19, line 36, after “periodically” delete “replace”.

At column 24, claim 5, line 19, after “have” insert --been--.

Signed and Sealed this
Eighteenth Day of September, 2012

David J. Kappos
Director of the United States Patent and Trademark Office